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**A COMPACT SUBMERSIBLE WINCH FOR A  
FAIRED TOWLINE**

**Leslie W. Bonde**

**Hydrospace-Challenger, Incorporated**

**Prepared for:**

**Naval Ship Research and Development Center**

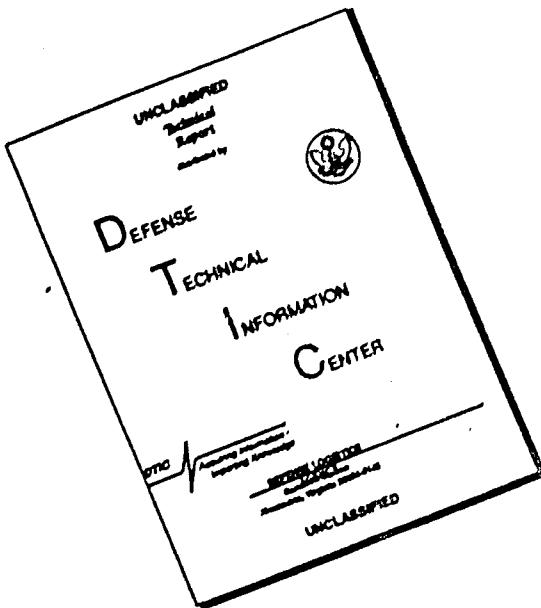
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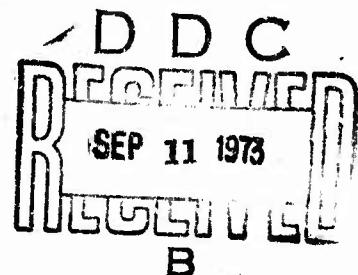
# A COMPACT SUBMERSIBLE WINCH FOR A FAIRED TOWLINE

## DEVELOPMENT REPORT PHASES I AND II

by Leslie Bonde

HYDROSPACE-CHALLENGER, INC.

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## **ABSTRACT**

This report documents the first two phases of the development of a research model of a submersible winch for high density storage of a faired towline. Phase I encompassed the determination of the technological feasibility of the concept through a preliminary design study and critical components investigation. Phase II included detail design, fabrication, assembly and checkout of the winch. Through land-based tests, operational characteristics of the mechanical elements and the adequacy of the drive system were demonstrated.

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## SUMMARY

This report documents the initial development of a special winch for a submarine communications system. The requirement for this winch was established in a prior study which identified a need for towline fairing in order to satisfy the desired performance specifications. Handling the requisite length of faired towline in the space available meant that a compact, submersible, multiple layer, concentric drum winch was necessary. This report documents the first two phases of the development of a research model of this winch. Phase I encompassed the determination of the technological feasibility of the concept through a preliminary design study and critical components investigation. Phase II included detail design, fabrication, assembly and checkout of the winch.

During the design study, the basic mechanical concepts for driving, fleeting, and arrangement of the concentric drums of the winch were independently reviewed and judged technically sound. The types and location of motor, gear train and brake were considered. A submersible two speed AC motor, gear train and brake mounted in the axle of the concentric drums were selected. Candidate materials for the winch were reviewed, and 316 stainless steel was selected for the basic drum system. The drum latching system, drum groove depth and pitch, and synthetic ball bearing materials were judged critical components and subjected to testing. No synthetic ball bearing materials proved suitable and therefore, stainless steel balls were used.

Based upon the affirmative results of the design study and critical component investigations, the detail design and manufacturing were accomplished. The winch was procured less motor and controller. This allows these expensive components to be selected with the benefit of known operating data for the winch mechanism.

Adequacy of the winch to comply with its design specification was determined through a two stage land-based test. Stage I was basically to verify the operational characteristics of the mechanical elements. Stage II was to demonstrate that the design load, speed and brake objectives had been met. The winch satisfactorily completed all tests. As a result of the test, the selected motor and controller should be procured, installed and tested.

Further testing of the winch with the intended faired cable should be accomplished. In parallel with this test the remaining elements of the system must be designed and manufactured so that complete system testing can be conducted on land and at sea.

## SECTION I INTRODUCTION

Present operational communications buoy systems for SSBN submarines have towlines which are either unfaired or partially faired with vibration damping streamers. The SSN 637 and 594 Class Submarines are being retrofitted on an interim basis with the BIAS system, which also employs vibration-damping streamers on the towline. The demand for operation at the higher speeds and/or greater depths posed by newer submarine designs (as specified in TDP S32-03)<sup>1\*</sup> exceeds the capacity of these systems. In order to obtain adequate communication depths at high speeds, the hydrodynamic drag on the towline must be limited by means of cable fairing. The addition of fairing to the towline requires that a mechanism for handling and storing the faired towline must be incorporated into the system.

A study<sup>2</sup> has been conducted based on a predesign analysis of the TDP performance specifications. This study recommends a high speed communications buoy towing and handling system for SSN 637 and 594 Class submarines and specifies a program plan to implement the development of the recommended system through an EDM submarine sea trial.

This study indicated that, in order to provide the SSN 594 and 637 Class submarines with a towed communications system which

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\* References are listed on page 5-1.

would meet the desired performance levels, two major constraints must be faced. First, the space limitations of the available cavity require a very compact buoy and handling system. This severely limits the design alternatives open to the system engineer. Second, the combination of high towing speed with depth requires a cable fairing to control the drag forces. These constraints act in opposition; the cable fairing requires a more bulky handling system than is needed by the ribbon-type material presently used.

A multi-layer, concentric drum winch was determined to be necessary in order to attain the desired compactness while protecting the fairing from the stresses of storage on a winch drum.

At the request of the Naval Ship Research and Development Center (NSRDC), Towed Systems Branch, Hydrospace-Challenger, Inc. (HCI) undertook a two-phase development program of a research model multi-layer, concentric drum winch. Phase I encompassed the determination of technological feasibility of the concept. This involved a preliminary design study and critical components investigation. Phase II of the program included detail design, fabrication, assembly and checkout of the winch. This report contains an account of the salient features of this development and the winch which resulted.

## SECTION II TECHNOLOGICAL FEASIBILITY DETERMINATION

A study<sup>2</sup> was conducted which identified the type and scope of faired towline necessary to meet the desired communications performance. The study found that a multi-layer concentric drum winch would be required in order to handle the faired towline. The salient requirements of the winch are that it:

1. handle faired cable;
2. be submersible;
3. operate by remote control; and
4. be highly compact and reliable

In order to satisfy these requirements, the concept is based on the use of:

1. multiple drums;
2. concentrically nested on a common shaft; and
3. traversing axially along the shaft for level winding

This concept is summarized by the acronym Submersible, Concentric, Axially Traversing (SCAT) winch.

In order to assess the technological feasibility of the concept, a design study to advance the concept to practical configurations was undertaken in parallel with an investigation of potentially critical components. Since HCI is not a manufacturer of marine equipment, it was decided that the design study should be subcontracted.

A request for proposal (RFP) was prepared and sent to reputable marine winch manufacturers. Proposals were received and evaluated. A subcontractor was selected in accordance with the RFP criteria. During prior studies<sup>2,3</sup> potentially critical components had been identified whose functional feasibility or reliability were in doubt. Therefore, a concurrent program to develop the components was undertaken.

## 2.1 PRELIMINARY DESIGN STUDY.

A subcontract was awarded to Western Gear Corporation to conduct the preliminary design study. This required the translation of the concept into preliminary hardware design. Reference 4 is the result of this study. It discusses the concept feasibility, subsystem and critical component design, interface requirements and possible system alternatives and options. In the following paragraphs, the salient points of this study will be summarized along with the rationale employed to arrive at the design.

### 2.1.1 CONCEPT. The SCAT winch concept described in Appendix A (attachment A) was used as the baseline for the study. Figure 2-1 shows diagrammatically the SCAT winch concept. The following paragraphs describe the functional concept.

When the cable system is fully deployed, the three concentric drums are "staggered" as illustrated in Step 1. The inner drum is splined to the central main shaft tube, but is free to traverse axially. Drum #2 is rigidly fixed to the right side winch frame by a latch. Drum #3 is similarly fixed to the left side winch frame by a latch. A fixed threaded outer housing enclosing Drum #3 is omitted for clarity.

At the center-plane of the winch, slots are cut in Drum #2 and Drum #3. These slots are aligned so that the faired cable has access to the inside drum.

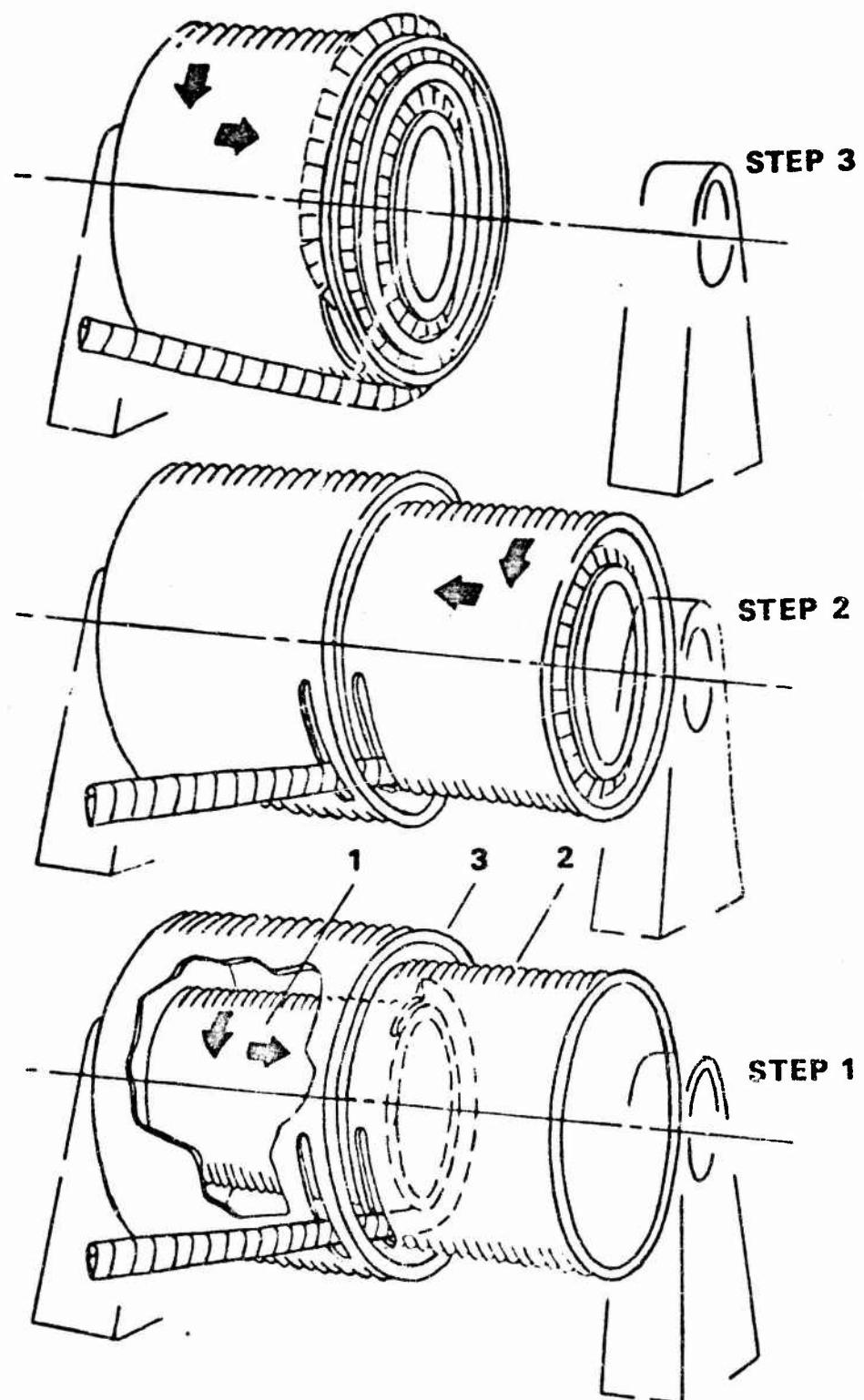


Figure 2-1. SCAT Winch Concept

Turning Drum #1 on retrieval hauls cable in through the slots in the outer drums and onto the groove in Drum #1, which moves to the right to keep its grooves aligned with the slot. The fleeting traverse is accomplished by threaded flanges on Drum #1 engaging an internal thread in Drum #2. The pitch of these threads is identical to the pitch of the drum grooving so that alignment with the slot is maintained. The last groove of Drum #1 forms a ramp on the left hand flange. At this point, Drum #1 has moved to the right until it is directly inside Drum #2, which has been fixed until this time to the right side frame.

When the cable spirals up the ramp groove on Drum #1, Drum #2 is unlatched from the frame and latched to Drum #1, so that it rotates with Drum #1. The edge of the slot in Drum #2 mates with the ramped groove in Drum #1. Thus, the cable begins to wind on Drum #2, which fleets to the left to keep its grooves in alignment with the slot in Drum #3 (Step 2).

Drums #1 and #2 fleet together (fleeting accomplished by threaded flange on Drum #2 engaging internal thread in Drum #3) past the slot in Drum #3, until the last turn of the cable grooves in Drum #2 is reached, as the two drums reach the left end of their travel, directly within Drum #3 (Step 3). The last groove in Drum #2 forms a spiral ramp on the right flange. A similar latching operation takes place, unlatching Drum #3 from the left side frame and latching it to Drums #1 and #2. Thus, the cable commences to wind on Drum #3 which moves toward the right with its threaded flange engaging a thread on the inside of the fixed outer shell. When the cable is fully retrieved, the drums are all nested at the right side frame.

Deployment is a reversal of the above described retrieval operation with the latches operating sequentially to unlatch and

release the drums in reverse order and to engage and fix the drums to the side frames.

2.1.2 STUDY GUIDELINES. Early in the study the following conclusions were made which guided the course of the study:

1. No preferred alternative drum traversing method was derived consistent with all design requirements. The feasibility of the internally threaded drum and flange drive concept was judged as technically sound but requiring detailed attention to materials, thread design, clearances, and techniques to minimize drum traversing loads.
2. An electric winch drive was judged preferable to electro-hydraulic, from noise, environmental, maintenance and ship interface considerations. A submersible AC motor system was judged superior to submersible DC from availability, size and maintenance considerations, even though variable speed control for an AC motor requires more sophisticated techniques than for DC. Discrete multi-speed control with dual or triple winding stators should be evaluated versus infinitely variable control via variable frequency.
3. Mounting the motor, gear train, and brake within the central support tube (i.e. axle) of the concentric drums was preferred for compactness. In addition, the internal mounting makes a totally sealed, oil-filled drive system practical.

4. The complexity of the drum latching system outlined above was considered a fundamental and critical problem, and therefore needing critical component development.
5. The drum groove depth and associated groove and thread pitch originally proposed were considered unnecessarily conservative to insure fairing alignment. Reduction in groove pitch and use of internal drum threads to maintain alignment of trailing edge of fairing was judged worthy of study. Major advantages resulting from pitch reduction and closer nesting of drums include:
  - a. feasibility of 3-drum SCAT winch configuration with comparable stowage capacity to 4-drum system
  - b. simplification of latching system by elimination of floating ring latch required in 4-drum system
  - c. permits enlargement of internal volume of central drum shaft tube consistent with maximizing volume available for possible internal drive system

This area was also subjected to critical component development.

6. Material selection, bearing and seal design is of obvious fundamental importance in order to insure operability and survival in corrosive fouling and high pressure environment.

**2.1.3 SCAT WINCH GENERAL ARRANGEMENT.** The general arrangement of the SCAT winch, which resulted from the study is shown in Figures 2-2a and b. The arrangement shown is 49" high x 66" wide, consistent with original installation compartment data, and has a stowage capacity of 1347 feet of faired cable plus two unused wraps of unfaired cable for a total of 1363 feet.

Figure 2-2a is a front sectional view of the winch, showing the nested arrangement of the grooved drums and the fairing alignment and guidance provided by the internal drum traversing threads. Flange inserts with threads matching the internal drum threads provide the drum fleeting mechanism.

The drums are mounted on a central main drive shaft with the inner drum "keyed" to the drive shaft by recirculating ball splines, designed to transmit the driving torque to the drums but minimizing the drum fleeting resistance under load.

The main drive shaft is supported by two large anti-friction ball bearings which permit the rotation of the drums with minimum resistance.

Mounted within the central shaft tube is a tubular housing enclosing the drive system (Figure 2-2b), consisting of a 40 hp, 440v, 3 phase, 60 Hz, 1800 rpm submersible electric motor, planetary gear reducer and spring set, multiple disc magnetic brake. All of these components are oil-filled and provided with a spring-loaded pressure compensation system. The tubular drive housing is mounted rigidly to the right side winch frame. The reducer output is coupled to the main drive shaft via a bulk-head mount, so that the entire drum system rotates about the fixed drive housing.

The volume at the left end of the main shaft tube is reserved for slip ring and sensor subassemblies.

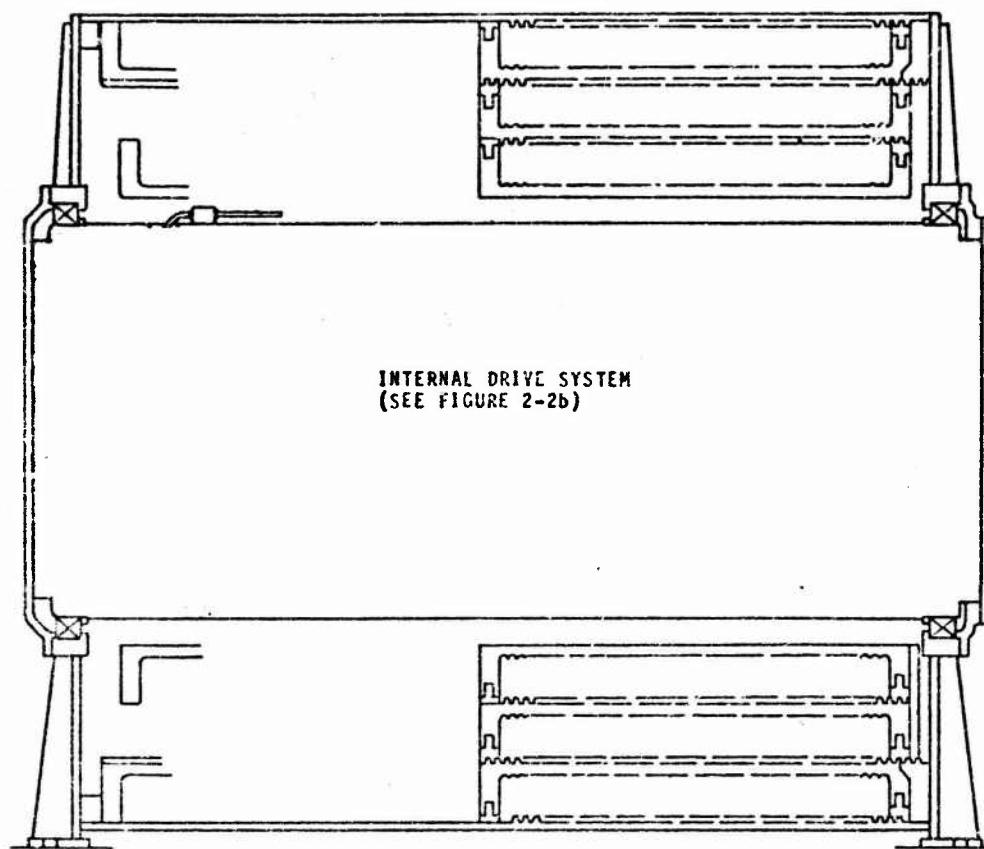


Figure 2-2a. Winch Cross Section

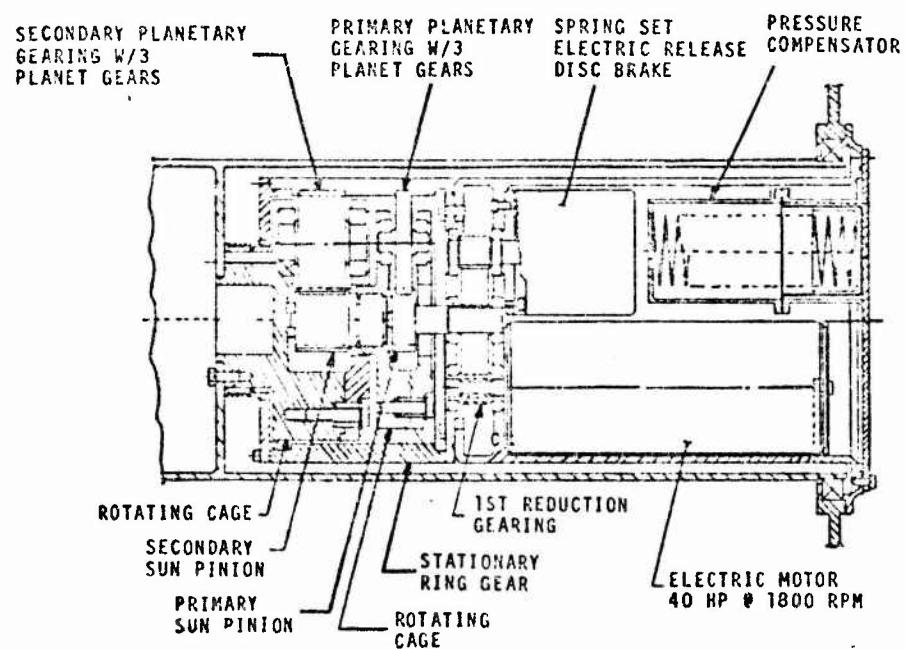


Figure 2-2b. Internal Drive System

2.1.4 MATERIALS. In order to maintain long term operability in the submerged environment, considerable attention was given to material selection. Consultation with Navy Materiel experts led to the selection of copper-nickel alloy (70-30) as the preferred choice for the basic drum system. Type 316 stainless steel would be quite adequate as a second choice for an engineering prototype to prove feasibility. This would provide a shorter equipment life at a considerable cost savings. Critical elements such as splines and latches would be made from inconel or monel. Due to its water lubrication, abrasion resistance, non-corroding properties, Ultra High Molecular Weight (UHMW), polyethylene was selected for threaded flange inserts on the drums. Also this material will be investigated for the main shaft and spline bearings. However, there is some uncertainty as to its static behavior under long term load, especially if a ball-type bearing is employed. The winch frame would be made of carbon steel suitably protected by a marine finish.

2.1.5 ALTERNATE SIZE. Due to a revised definition of the existing winch compartment received during the latter part of the study, the previously discussed design was scaled down to a 47" high x 56" wide winch. The slight diameter reduction could be achieved without significantly affecting the total drum and drive system. The decrease in width reduces the available end volume within the central drive tube for slip ring and sensors. The most significant effect is on the total faired cable storage capacity which is reduced from a total scope, including two unused wraps, of 1363 feet to 1049 feet. System performance capability with required towline speed and pull will be identical for both sizes.

2.1.6 DRIVE. The adaptation of the BIAS drive to the SCAT winch as an interim drive system was considered. If the BIAS drive was used, a severe compromise in performance would have to be accepted, and therefore this approach was abandoned in favor of a standard

off-the-shelf design: the Franklin Electronic Sea-Mersible Motor with appropriate reducer, brake and controller. Both single winding with variable frequency speed control and dual winding two-speed motors were found suitable. However, concern with electrical noise interference generated by an SCR variable frequency controller established the two-speed motor as the preferred drive option.

## 2.2 CRITICAL COMPONENT INVESTIGATIONS.

From program outset, certain components were recognized whose functional feasibility or reliability was in doubt. Examination and verification or identification of other components by the design subcontractor was performed so that a test program could be instituted which would allow the following:

1. selection between alternate component approaches;
2. establishment of component feasibility; and
3. improvement of component reliability.

Three investigations were conducted and are discussed in the following paragraphs.

2.2.1 DRUM GROOVING AND PITCH. In order to assure fairing orientation on the drums, a deep groove was contemplated. This required relatively large pitch in order to maintain adequate strength in the groove walls. Conversely, with a shallower groove, the associated pitch could be decreased. However, the alignment of the fairing tail must be maintained. The study subcontractor suggested that the alignment of the fairing tail pieces could be maintained by allowing them to engage in the internal thread grooves of the next drum. The major advantages resulting from pitch reduction and thread groove alignment are the same as 5a through 5c of paragraph 2.1.2.

Since the reduced groove depth and pitch deviated from the approach originally conceived and greatly influenced the SCAT design, a grooved sleeve was fabricated and installed at the HCI test facility in Martinsburg, West Virginia. Eleven 7/32-inch deep grooves on a 17/32 pitch were machined into a split sleeve which fit an existing winch's 18-3/16 inch diameter drum. The sleeve was split so that it could be installed on the drum by welding. Figure 2-3a shows the grooving with bare and faired cable installed on a traversing winch drum. Figure 2-3b is a similar side view. The fairing was observed while being payed-out and in-hauled under a 400-pound load. Once a fairing section came in contact with the grooving its attitude would not change unless disturbed by an adjacent on-coming section. Incoming fairing sections tended to rub on the already-wound nose-pieces and catch on rivet heads or discontinuities. This resulted in the rotation of prior sections toward in-coming sections with the danger of over-winding the tail of adjacent sections. From those tests it was concluded that the grooving depth and pitch must be increased. After study a new groove depth of 1/4-inch (1/2 nose-piece diameter) and a pitch of 9/16-inch was selected.

The results of the drum grooving test were encouraging from the standpoint that a sectional fairing will maintain its orientation without deep grooves; therefore, the design subcontractor was directed to concentrate his efforts on optimizing the three-drum SCAT winch configuration.

**2.2.2 DRUM LATCHES.** Securing and releasing the drum from the fixed side support structure required a highly reliable, positive and simple device. A self-actuating and purely mechanical mechanism was considered as the only acceptable means due to the reliability and controllability problems that might be encountered in an electro-mechanical device.

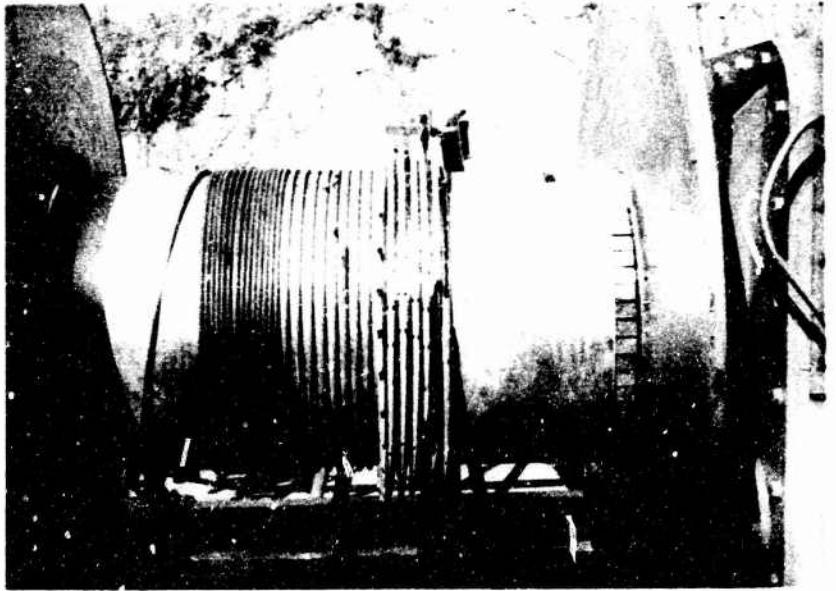


Figure 2-3a. Rear View of Drum Grooving  
with Bare and Faired Cable Installed

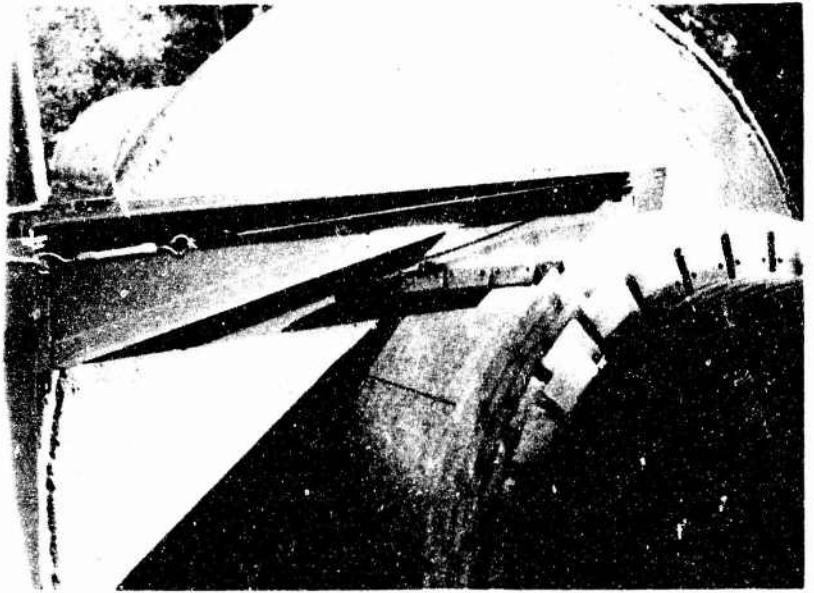


Figure 2-3b. Side View of Drum Grooving &  
fairing. (Note erectness of fairing).

Due to the critical nature of the latch operation to the SCAT winch success, considerable effort was expended in refinement of the mechanism described in Appendix A by both the design study subcontractor and HCI during this phase of the program. Figure 2-4 shows a full scale model of the design selected as the most promising. The model represents a segment of Drums #1 and #2 (Figure 2-5) which pivot about a common axle supported by side plates. Mounted on one side plate is Drum #2 fixed stop (Figure 2-6). The grooves in the bottom of the model next to the stop represent the drum threading. The model was used to demonstrate feasibility and reliability of the concept. After minor adjustments the model satisfactorily demonstrated latching and unlatching. In order to understand latch operation, a sequence is shown in Figures 2-7a through 2-7c. Figure 2-7a shows the approach of a fully loaded Drum #1 as it approaches the right side winch frame (see Figure 2-1) and is about to engage Drum #2 and release Drum #2 from its fixed position on the right side plate. Drum #2 at this point is rigidly held to the fixed side plate by a spring actuated latch and stop engaging a fixed stop on the side plate. The driver block on Drum #1 cams the spring-loaded latch on Drum #2 releasing it from the fixed stop on the side plate (Figure 2-7b). Drum #1 and Drum #2 are now linked together and begin to traverse back toward the left side plate (Figure 2-7c) where Drum #3 will be similarly disengaged from the left side plate and picked up by Drums #1 and #2.

2.2.3 SYNTHETIC BALL BEARING MATERIALS. Through consultation with various Navy experts, the use of Ultra High Molecular Weight (UHMW) polyethylene for bearings exposed to a submerged marine environment was highly recommended. However, prior applications had principally used journal bearings rather than ball bearings. In order to maximize winch storage capacity, the main shaft bearing width was to be minimized. A ball bearing was selected over a journal bearing because it was believed that an equivalent journal for the load and speed required would need a face width of two to three

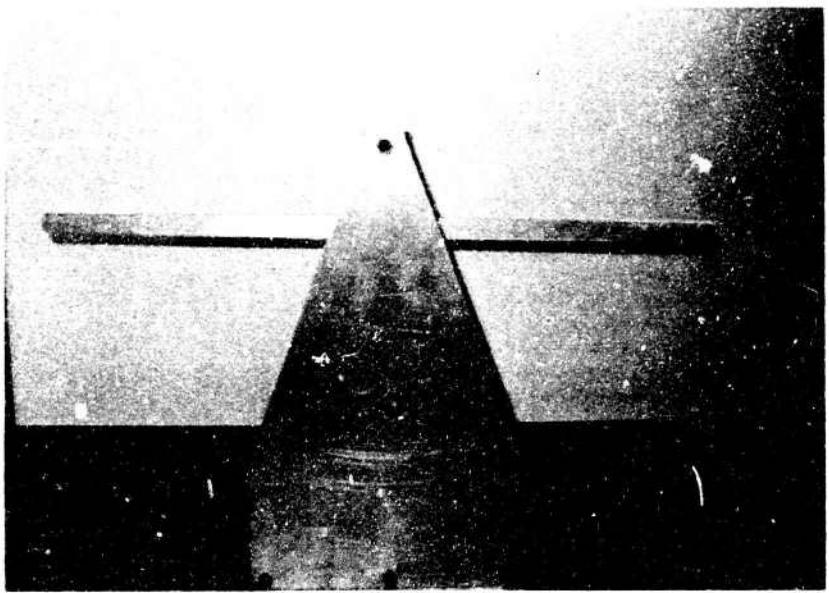


Figure 2-4a. Latch Model Side View

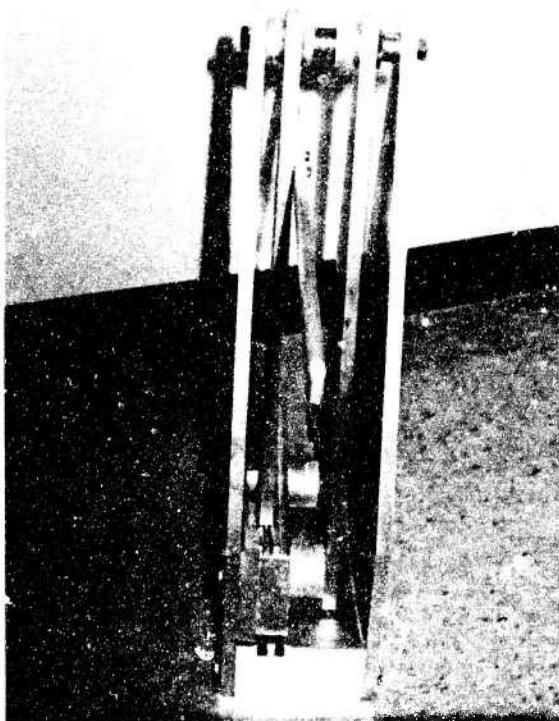


Figure 2-4b. Latch Model End View

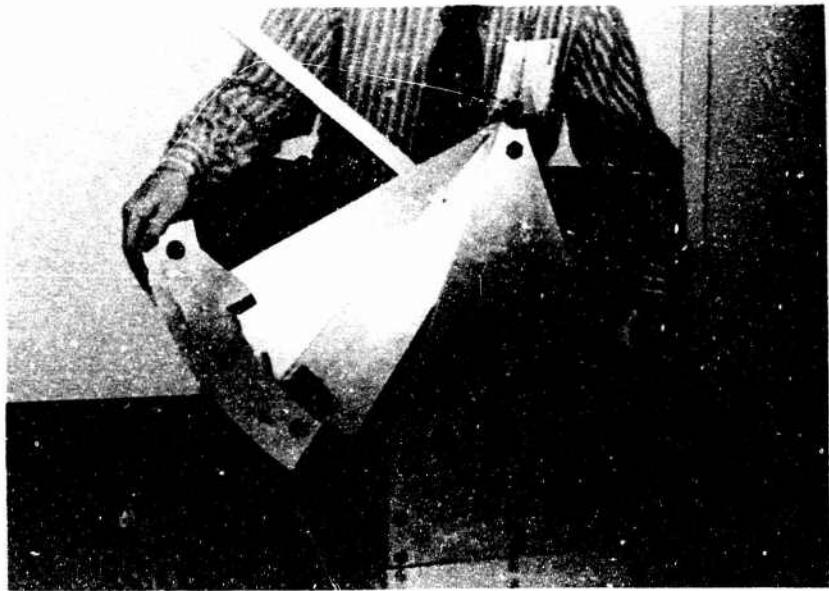


Figure 2-5. Drum #1 with handle attached, Drum #2 held by hand.

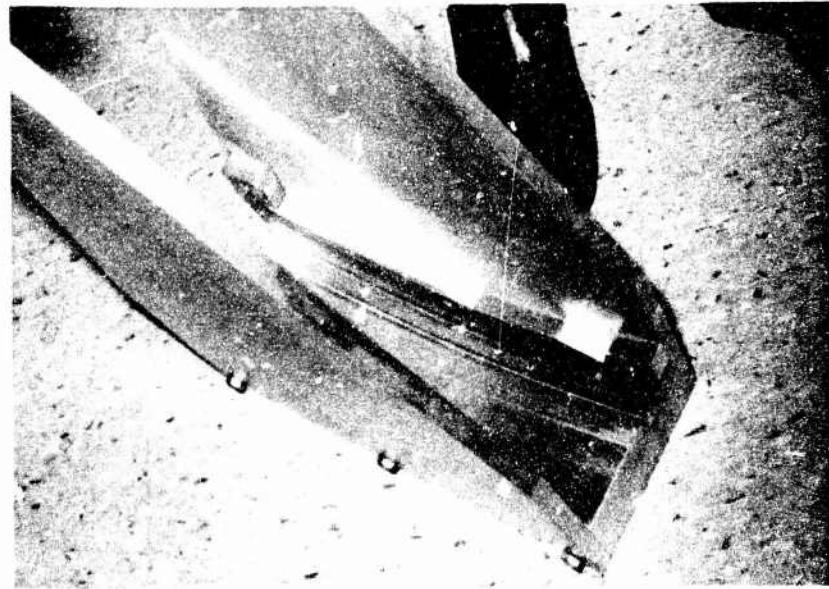


Figure 2-6. Drum #2 fixed stop on side plate



Figure 2-7a. Drum #1 Approaches Drum #2

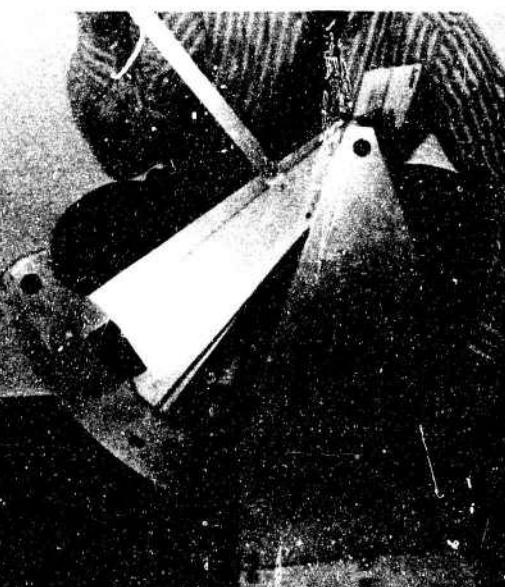


Figure 2-7b. Drum #1 Engages, and Releases Drum #2 from Side Plate

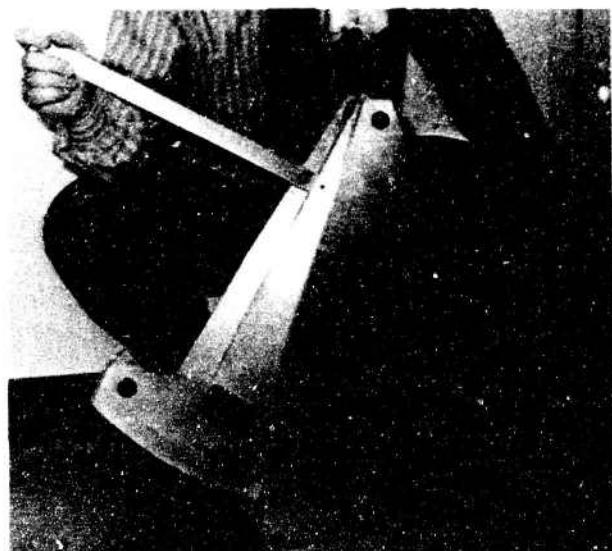


Figure 2-7c. Drums #1 and #2 Latched Together

times that of a ball bearing. To minimize friction force in traversing the drums, a recirculating ball spline approach was selected over a sliding keyway.

The UHMW polyethylene material appeared promising due to its high strength, self-lubricating and non-corroding properties. Calculations performed during the design study indicated adequate strength. However, there was some uncertainty as to their static behavior under long term loading. Due to sponsor preference at the final review of the design study for non-metallic bearings, it was concluded to proceed with the design based upon the synthetic ball since corrosion-resistant metallic ball elements could always be substituted at a later date if long term loading became a problem.

In order to obtain data on the loading capability of the UHMW balls, samples were procured along with other potential candidates. A test apparatus was built in which the balls were loaded similarly to the SCAT recirculating spline. Figure 2-8 shows diagrammatically the test apparatus. A known weight was positioned along the beam at a known distance. The load applied to the ball loading fixture was then calculated. A dial indicator was used to measure the deflection of the balls by sensing the movement of the fixture. Figure 2-9 shows the fixture and dial indicator. Figure 2-10 shows the fixture disassembled with balls. Six balls of candidate material were used in each half of the fixture. Three were 3/4-inch diameter and three were 1/16-inch diameter undersized idlers used to maintain separation and prevent scrubbing between the load-carrying balls.

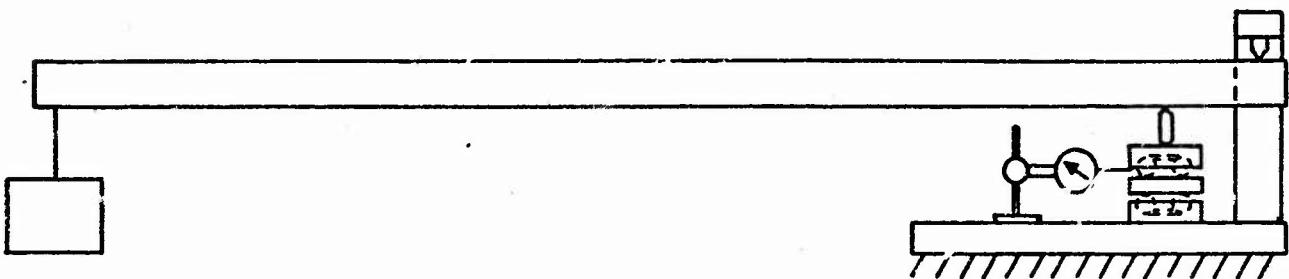


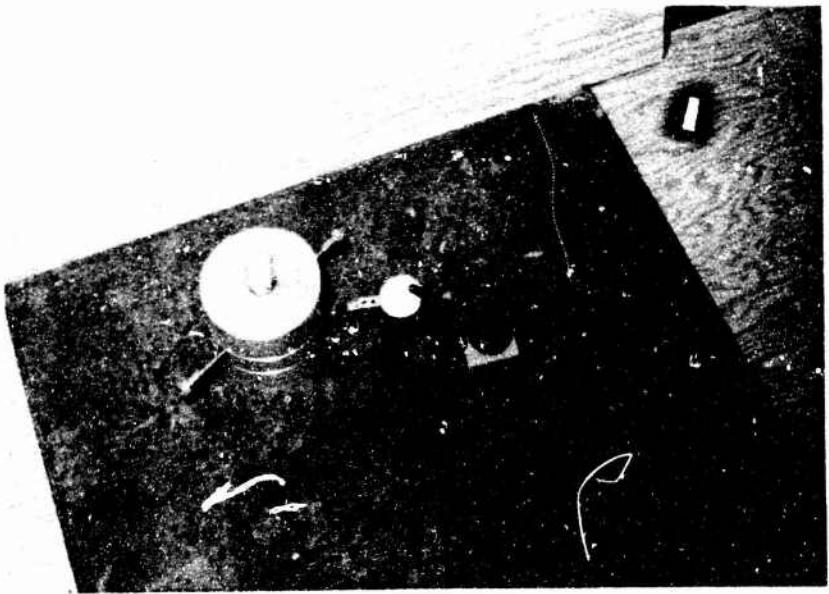
Figure 2-8. Test Apparatus Diagram

During the detail design phase of the program, testing of balls of various non-metallic materials was conducted. Tests were conducted on polypropylene (unfilled and filled with 10% and 30% glass), polyester (10% glass filled), nylon, polystyrene and polyethylene. All materials deflected excessively under the 500 pound per ball design load. In all cases, the balls slid in the fixture at design load instead of rolling. In some cases, the fixture could no longer be rotated by hand due to flattening of the balls. Selected balls were tested for long term static load. Deflection continued after a period of less than a day, so testing was terminated. All balls tended to return to original shape after unloading, given sufficient time.

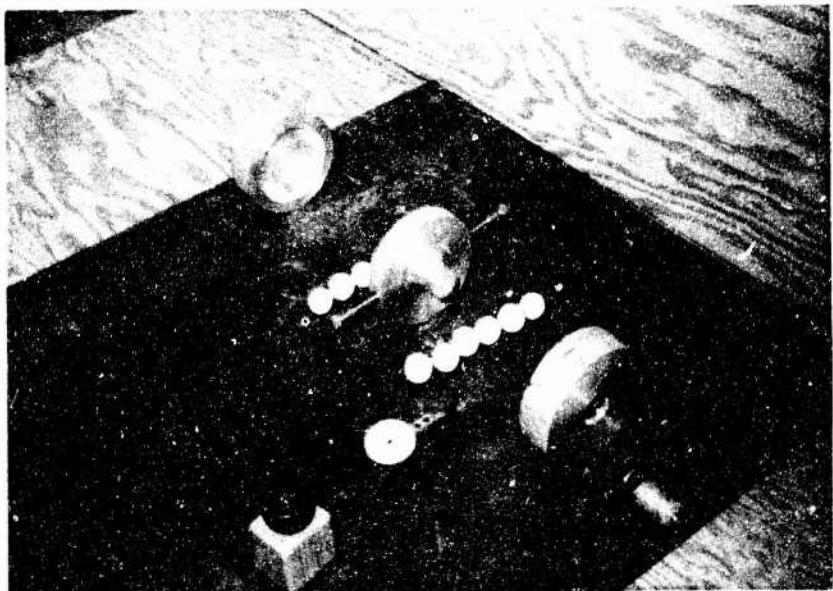
### 2.3 SUMMARY.

As a result of the design study and critical component investigations, it was concluded that the SCAT winch concept is basically feasible, can be manufactured, and represents a promising solution to the remote handling of sectionally faired cable in a highly compact, submersible system.

Preliminary design plans and data were developed for two similar SCAT winch configurations. The configurations differ only in size (and consequent cable storage capacity), and have identical drive performance characteristics. In order to minimize structural



**Figure 2-9. Ball Test Fixture with Dial Indicator**



**Figure 2-10. Fixture Disassembled with balls**

modifications for installation and removal from the submarine cavity, it was concluded that the reduced capacity (1049 feet), 47-inch high x 56-inch wide, model be developed in Phase II.

With technical feasibility affirmed, the groundwork for Phase II was laid by the preparation of a proposal by the design study subcontractor for the design, construction and factory checkout of the SCAT winch. This proposal summarized the study and the sponsors preferences where alternates were available in the form of a specification (Appendix B) for the SCAT winch.

## SECTION III HARDWARE DEVELOPMENT

Phase II of the program was initiated with the award of a contract to Western Gear Corporation, due to the experience gained during Phase I to perform detail design, fabrication, assembly and checkout in accordance with the SCAT winch specification (Appendix B).

Since some doubt existed as to the speed at which drum latching could be accomplished, it was decided to procure the winch, less motor and controller. Initial testing to assure specification compliance from the mechanical functioning standpoint would be accomplished with an external variable speed drive. This would allow determination of the performance characteristics of the major elements of the winch without the commitment of the motor and controller. Once operability has been demonstrated, the drive motor and controller could be procured, including, if necessary, a "latch speed" in addition to operating speed.

From the cost standpoint, it was decided to procure Type 316 stainless steel for the basic drum system of the SCAT engineering prototype winch, instead of the copper-nickel (70-30).

### 3.1 DESIGN.

The groundwork was laid for the detail design of the SCAT winch during Phase I of the development. The major trade-offs had been made so that detailing could be efficiently accomplished. In accordance with the program schedule, a design review conference

was held in March 1972 with Navy sponsors present. In this review, the mechanical and electrical termination of the cable to the winch was judged inadequate. Experience with the BRA-8 system dictated that the complete cable, from the slip ring to the buoy, must be removable without disassembly of the winch.

Candidate alternatives for terminating the cable which would facilitate installation and removal of the cable from the winch were developed, and the most promising passed on to Western Gear Corporation. In this approach, the armor wires of the towcable are terminated in a cylindrical cast epoxy fitting which is clamped to the inner drum. The electrical core, would be suitably jacketed for abrasion resistance. The core would be pulled by a leader installed at winch assembly through a hole in the inner drum into the space between the main drive shaft and the inner drum to the slip ring cavity. Part of this space is occupied by the recirculating-ball spline assemblies. A guide tube is attached to the inner drum to direct the core as it is inserted through the hole. Other guide plates prevent the core from entangling the spline assemblies, while permitting a slack loop to form in the core to allow for the traversing of the drum along the splines. A second guide tube on the main drive tube directs the core through a hole in the drive tube to the slip ring chamber.

The contract with Western Gear was modified to incorporate this approach in lieu of the original termination and slack cable compensator.

Appendix C contains the assembly and subassembly drawings of the SCAT winch. The parts list for each assembly is included.

Drawing E301207, Sheet 1, is a frontal section view of the winch showing the nested arrangement of the grooved drums. Flange

inserts with threads matching the internal drum threads provide the drum fleeting, as shown at the centerline of the winch.

The drums are mounted on a central tubular main shaft, with the inner drum "keyed" to the shaft by recirculating ball splines which transmit the driving torque to the drums. The main shaft tube is supported at either end by two large anti-friction ball bearings.

Drawing E301207, Sheet 2, is a side view of the winch assembly showing the mounting arrangement and foundation framework. The lower left cutaway portion shows the geometry of drum slots and cable ramps which provide smooth cable transition from drum to drum. Also depicted in this drawing is the arrangement of the recirculating ball splines around the main shaft, and the cable termination in the upper right quadrant.

Drawing E301215 shows the innermost drum assembly (#1) with the recirculating ball spline races mounted at three places around the inner circumference. One of the electrical lead guide tubes is shown in the space between two of the splines. Drawing E301216 shows Drum assembly #2 with the arrangement of the drum flange latching mechanism. Drawing E301217 shows the outermost Drum assembly (#3) with its latch mechanism.

Drawings D303915 and D303916 show the right and left hand side plate assemblies. The outer shell ties these two assemblies together. The plates support the main shaft bearings. Attached to each plate is the portion of the mechanism which unlatches Drum #2 or #3 from the internal nested drum(s), decelerates, and latches it in the stored position. The side plates provide the structure for mounting the winch on a foundation.

Drawing D303919 shows the main shaft assembly, on which the drums are mounted by the recirculating ball splines. The spline's inner races run the length of the tube. The electrical cable guide is also shown between the lower two spline races.

Drawing D303929, Sheet 1, shows the end view of the inner shaft assembly, which serves as a support housing for the drive train. Sheet 2 is a sectional view of the inner shaft. Within the shaft is the planetary gear reducer, spring-set multiple disc magnetic brake, pressure compensator, and the motor coupling shaft. This shaft is used for attaching a hydraulic motor for powering during feasibility testing. Removal of the motor coupling shaft and machining of the planetary end of the support housing will allow installation of the 40 hp submersible electric motor. The spring-loaded pressure compensation system is attached to the brake. The inner shaft is mounted rigidly to the left side of the winch frame to support the drive train (as viewed in Drawing E301207 Sheet 1) whereas the reducer output transmits torque via a bulkhead on the end of the main drive shaft tube so that the entire drum system rotates about the fixed drive system.

### 3.2 MANUFACTURING.

Manufacturing review at Western Gear Corporation required modifications to the drum assemblies. For ease of fabrication, the flanges were bolted in lieu of welding. The flange on the unthreaded side of Drum #3 (the outermost) was relieved to prevent possible binding in the event of structural deflections. The threaded flange of Drums #2 and #3 were counter-bored to facilitate lead in and support.

Major difficulties were experienced during the manufacture of the drums: first, delayed material delivery and second, the ability to hold the close tolerances associated with the thread design.

Since this was a prototype, extensive tooling was not produced. In production, "hard" tooling would be fabricated which would ease the machining problems. Also ring casting would be used rather than rolling and welding plate. This should ease the material availability problem as well as reduce cost.

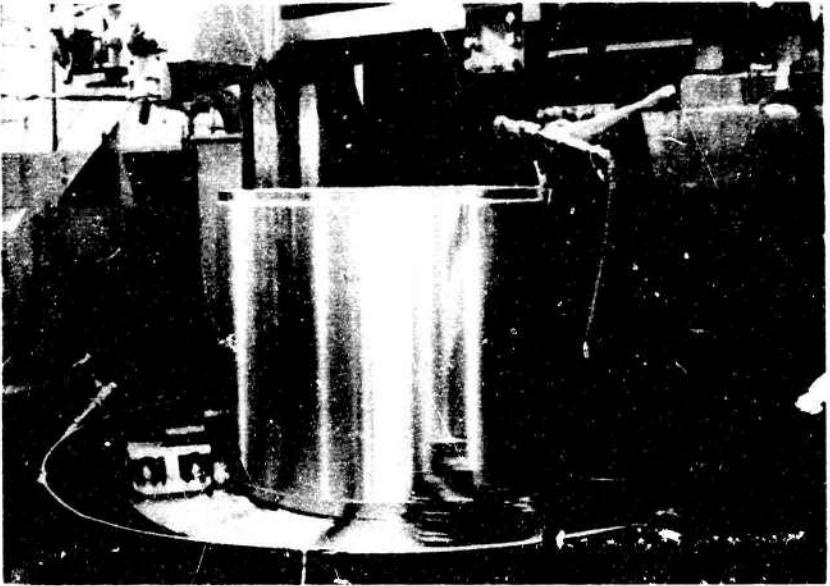
Difficulty in assembling the recirculating ball races to the main shaft and Drum #1 was experienced. Each race position had to be aligned very carefully so that the balls would run smoothly without binding. This was a very time consuming operation. In future models, this should be redesigned to ease assembly.

Figures 3-1 through 3-10 show parts at various stages of manufacture.

### 3.3 TEST.

To determine the adequacy of the SCAT winch to comply with its design specification, a land-based test was conducted in two stages. Stage I was basically to check out the operational characteristics of the mechanical elements. Stage II was for determining the adequacy of the drive system to meet the design load, speed and brake objectives. Also the structural integrity of the components would be determined. The detail test description and data sheets are contained in Appendix D.

3.3.1 EQUIPMENT. The winch was attached to a specially fabricated foundation which inclined it to an operational attitude and provided the mounting for a sheave to provide proper cable entry. A fixed displacement ( $5.98 \text{ in}^3/\text{rev}$ ) piston type hydraulic motor (Vickers MF-2020-30-95-21) was coupled to the input drive shaft of the reducer and mounted to the bracket attached to the inside of the inner shaft. Hydraulic power was supplied to the inside motor by a variable displacement pump. The relief valve pressure



**Figure 3-1. Drum Being Machined  
(Prior to Grooving and Threading)**



**Figure 3-2. Drum Flange (Prior to  
Machining Thread into Insert)**



Figure 3-3. Side Plates

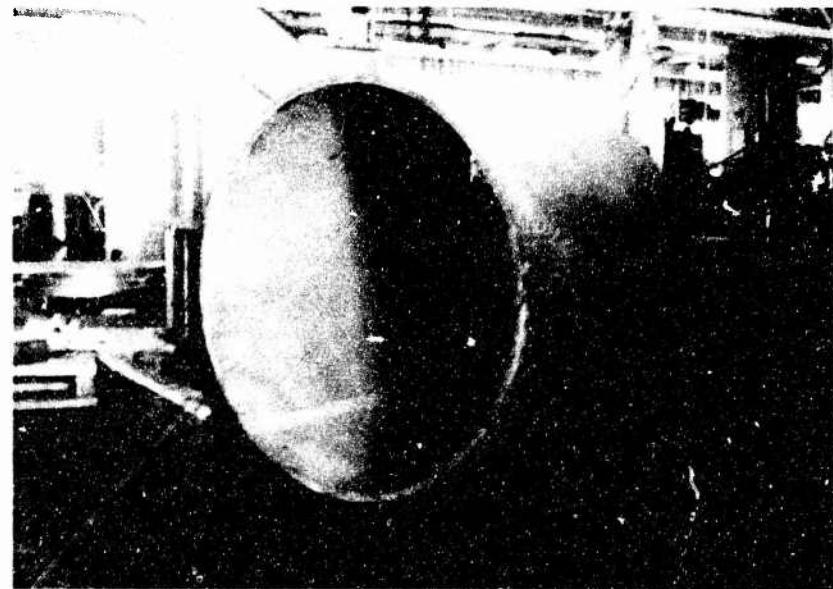


Figure 3-4. Outer Housing  
(prior to machining)

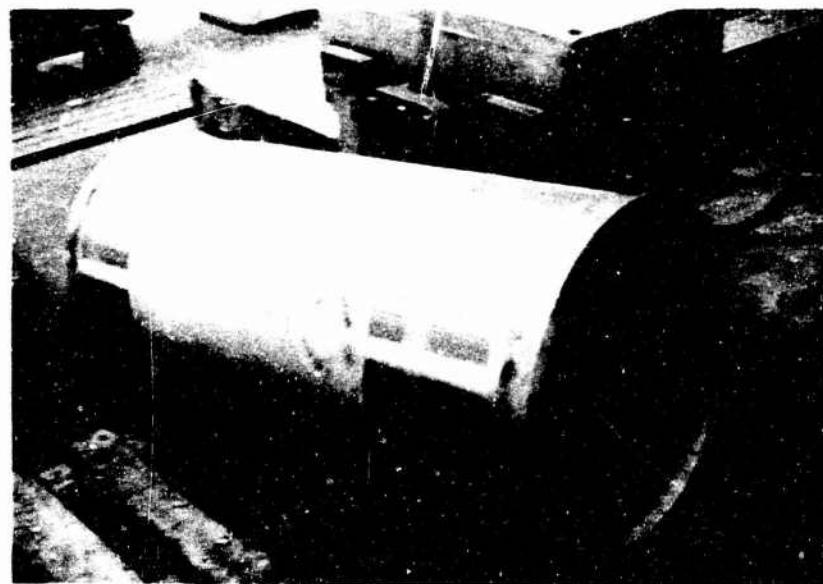


Figure 3-5. Main Shaft (rough machined)

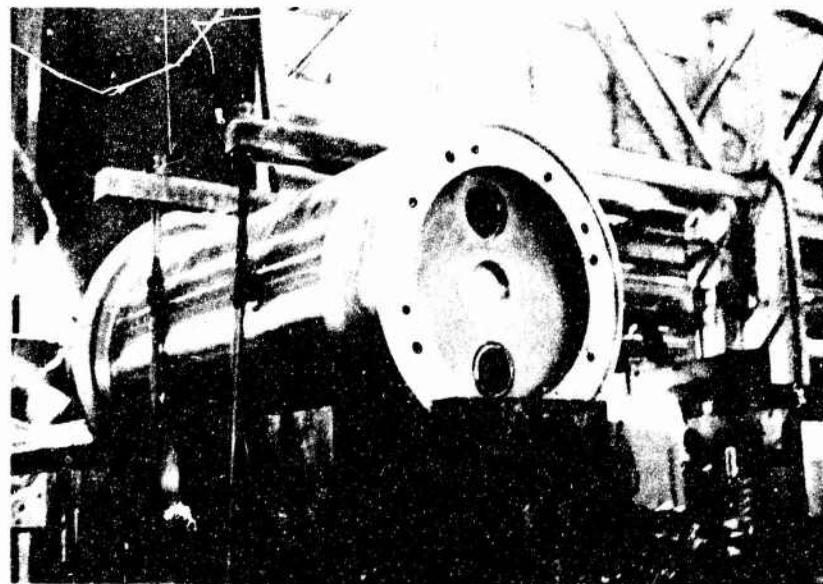


Figure 3-6. Inner Shaft Housing  
(Planetary Gear Reducer-end)

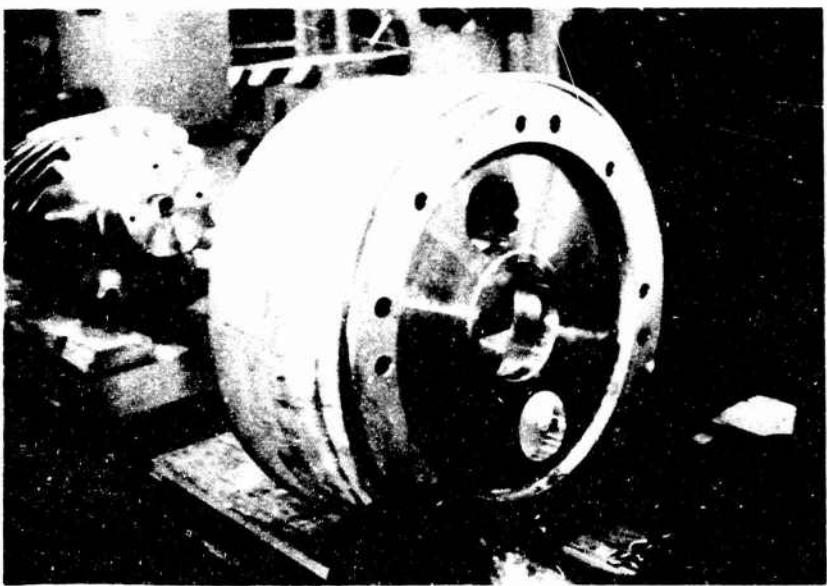


Figure 3-7. Planetary Gear Reducer Housing

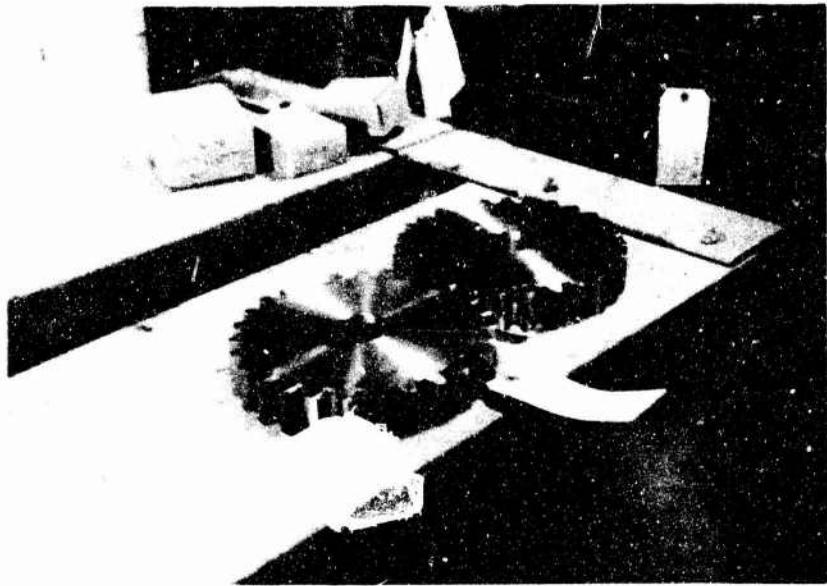


Figure 3-8. Second Stage Planetary Sun Gears

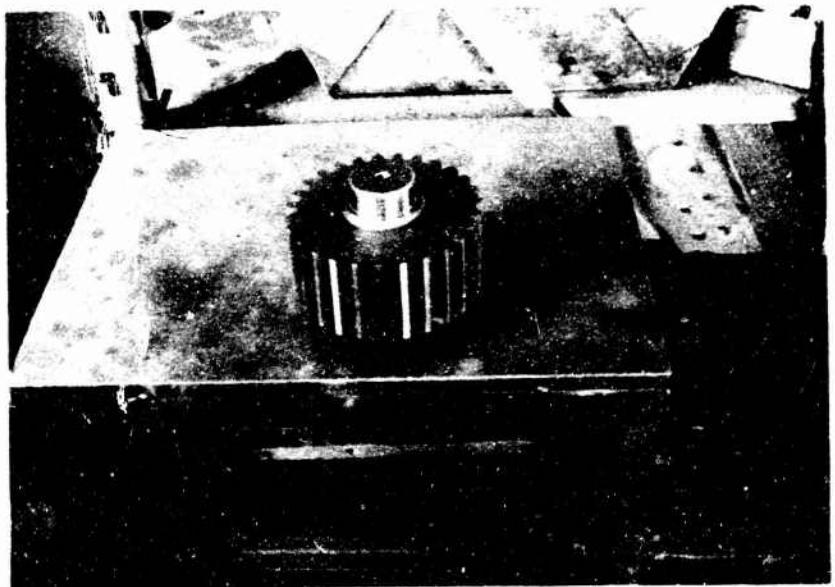


Figure 3-9. Third Stage Planetary Sun Gear

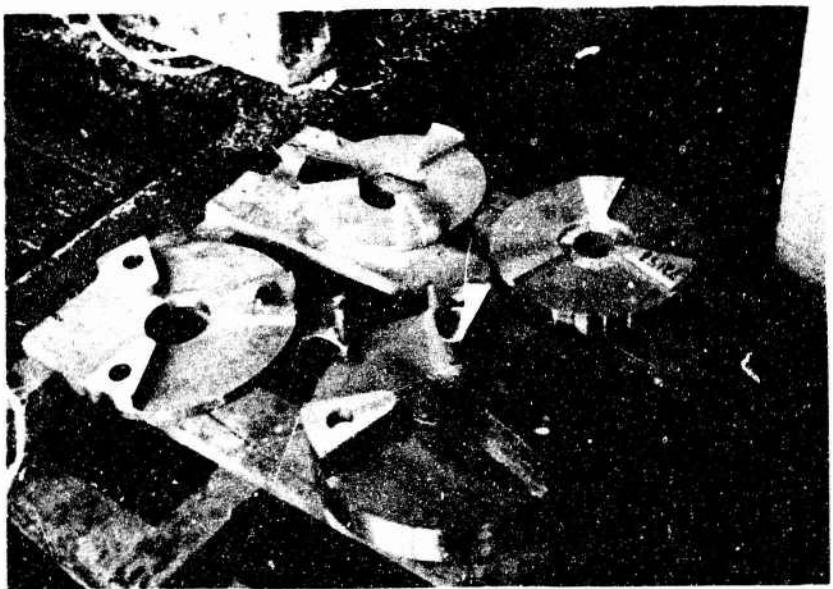


Figure 3-10. Planetary Sun Gear Carriers

setting was adjustable. By setting relief pressure only 150 psi above that required to conduct the test, a means was provided to prevent catastrophic damage. In the event of an overload due to component failure, the relief valve would open to prevent the motor from applying its full torque and possibly causing further damage or injury. Figure 3-11 shows the hydraulic motor installed. A 1/2-inch wire rope of appropriate length was used during Stage II in conjunction with the Western Gear test tower, calibrated weights and a back-up winch.

Motor input and back pressure were measured with two calibrated gauges. Motor rpm was measured stroboscopically and checked by timing drum rpm's and accounting for the speed reducer. Figure 3-11 also shows the pressure gauges and the strobe.

Brake test was conducted using a 5-inch bore by 2 1/2-inch diameter rod hydraulic cylinder and a portable power supply with a pressure gauge.

**3.3.2 PROCEDURES.** Stage I was conducted in the contractor's hydraulic assembly area. The operating characteristics of the mechanical elements were determined. This was accomplished by operating the winch very slowly under no load in pay-out and in-haul directions through each latch, and recording the corresponding hydraulic motor pressure and rpm. Once latch operation had been verified, the speed was increased until maximum and minimum latching speed was determined. This was repeated for each drum.

After determining satisfactory latch speed, the winch was run in and out for 15 minutes at half-speed (motor speed = 900 rpm) full-speed (motor speed = 1800 rpm). During this period, motor data, gear case and drum bearing temperatures were monitored.

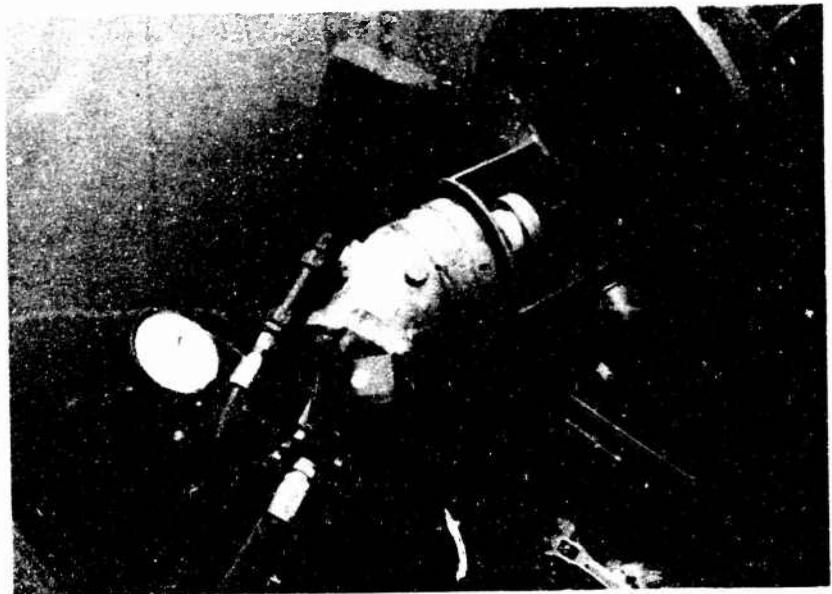


Figure 3-11. Hydraulic Motor Installation  
(Strobe in Foreground)

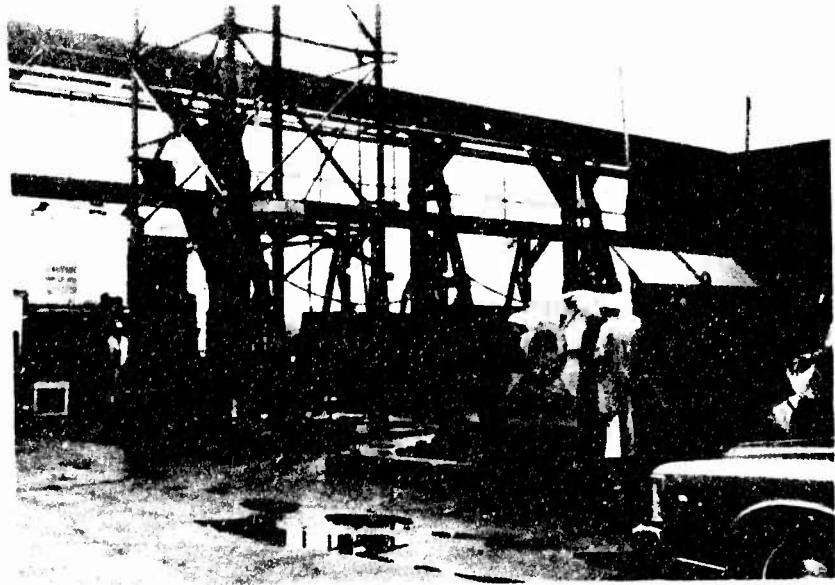


Figure 3-12. Winch Mounted at Test Tower

Stage II was conducted at the contractor's test tower (Figure 3-12). The winch and foundation was mounted on the test pad (Figure 3-13). A back-up winch was installed on the other side of the tower. The test cable was installed on the back-up winch and rigged through the pulley arrangement on the tower (see Figure 1 of Appendix D). The winch was operated under light load (100-500 lbs) at slow speed, while the test engineers recorded data, observed latch operation (Figure 3-14), watching for any indication of roughness when cable shifts from one drum to the next. The latching speed was increased to determine maximum speed under light load. The load was then increased to 2800 lbs and operated for 15 minutes at one-half speed, slowing down for latching as necessary. Motor data and temperature were monitored throughout the test. This test was repeated at full-speed. The load was then increased to rated capacity (5600 lbs), and operated at one-half speed for 15 minutes and full-speed for 45 minutes. Motor data and temperatures were monitored throughout.

The brake was tested by fully loading the winch with cable, attaching a hydraulic cylinder to the cable and pressurizing to 970 psi. Figure 3-15 shows the hook-up for the brake test. Any brake slippage was measured by observation of drum or input shaft rotation.

**3.3.3 RESULTS.** The SCAT winch satisfactorily completed the land-based tests, although some minor difficulties were experienced in latching. Under slow-speed and no-load in both in-haul and payout directions, latch actuation was not completed until approximately one-quarter turn of the drum past the designated latch position had been accomplished. It was concluded that friction between the drum threads prevented complete actuation at designated position. However, satisfactory actuation was completed after the additional one-fourth turn in all cases. This problem occurred below 500 rpm (input) for the latch between drums #2 and #3, and 350 rpm for the latch between drums #1 and #2 in the pay-out direction. The latch operation problem was experienced below 150 rpm during in-haul.



Figure 3-13. Winch and Foundation  
Mounted on Test Pad

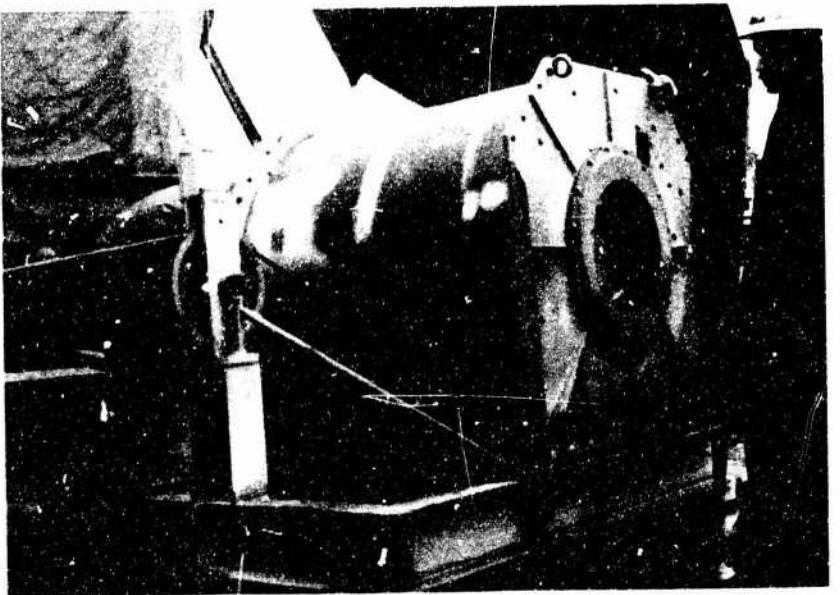


Figure 3-14. Winch Under Load Test.



Figure 3-15. Winch Brake Test

At high speed, above 1000 rpm, under no load, latch impact noise became excessive. During high speed latching one of the urethane cushions on the drum fixed block was lost. Latching was demonstrated without cushion and without damage to the fixed block.

Under light load, at one-half speed, no latch operation problems were experienced. The cable spooled on and off the drums through the transitions (ramps) without problems, noise or jumping. Cable entrance clearance through outer closure remained constant. No motor pressure spikes during latch operation were detected. Latch operation was somewhat quieter under load. Above 1500 rpm pay-out and 1300 rpm in-haul, latch noise became excessive. Additional load did not reduce operating noise noticeably.

Motor data and temperatures were recorded on data sheets contained in Appendix D (sheet 7 through 9). Motor pressure increases of 20 to 25 psi were detected when the drum(s) were driven up the 10° incline over that required for driving down the incline. A motor pressure increase of approximately 100 psi for each succeeding drum was detected under half load, at both half and full speed. This increased to approximately 150 to 200 psi under full load.

No drum or input shaft rotation was detected during the brake test. After brake test, all motor pressure and full load operation were normal. Through external visual inspection, no structural damage could be detected.

**3.3.4 ANALYSIS.** To determine the input horsepower requirements it was necessary to determine the hydraulic motor torque output. This allowed calculating horsepower by the conventional formula. The motor used, supplied 95 in-lb/100 psi, with 95.1% and 93.9% efficiencies at 900 and 1800 input rpm respectively.<sup>5</sup> Due to the small change in efficiency with speed, the lower efficiency was used throughout in calculating motor output torque. This yielded a

horsepower approximately 1% greater than required. The following expression was used for calculating the motor output torque in inch-pounds:

$$T = .89p \quad (3-1)$$

Where  $p$  was the motor pressure in  $\text{lb/in}^2$ . When Equation 3-1 was combined with the horsepower equation,

$$Hp = \frac{nt}{63,000} \quad (3-2)$$

the following expression was produced

$$Hp = 1.4 \times 10^{-5} np \quad (3-3)$$

where  $n$  was motor rpm. Using Equation 3-3, the horsepower was calculated for each test condition.

The cable horsepower was similarly calculated using Equation 3-2, using  $F$  for the cable tension, and  $R_i$  for the drum radius being filled. However,  $n$ , the input motor rpm was divided by the gear box reduction (108.34) to provide the drum rpm. The following equation resulted from the above substitutes:

$$H_{pc} = \frac{n F R_i}{6.825 \times 10^6} \quad (3-4)$$

Values  $H_p$  and  $H_{pc}$  computed from test data are given in Table 3-1 for various conditions.

TABLE 3-1. CALCULATED HORSEPOWER

Cable Load	Average Motor RPM	No Load <sup>1</sup>	Cable <sup>2</sup>	Total <sup>3</sup>	Actual <sup>4</sup>
2800	935	3.0	5.2	8.2	10.5
		3.7	7.8	11.5	13.4
	1810	10.0	10.0	20.0	19.0
		11.0	15.0	26.0	26.0
5600	910	3.0	10.3	13.3	10.3
		3.7	15.1	18.8	16.9
	1805	10.0	20.4	30.4	25.3
		11.0	29.9	40.9	39.2

<sup>1</sup> Equation 3-3, with no cable.

<sup>2</sup> The first number in the pair used the radius of Drum #1 and the second used radius of Drum #3, equation 3-4.

<sup>3</sup> No load plus cable.

<sup>4</sup> Equation 3-3, with cable loading as indicated.

Brake test load, P, was determined by the following expression:

$$P = pA \quad (3-5)$$

where  $p$  was the hydraulic cylinder pressure and  $A$  was the cylinder area. Substituting in the cylinder bore and rod diameters, and the measured pressure, a load of 14,285 pounds was calculated.

**3.3.5 DISCUSSION.** As a result of the test, it was concluded that latching should be accomplished at half speed, which is also required for buoy nesting. Thus two speeds satisfy the essential

operating requirements, whereas more would add additional cost and complexity to the drive and control system. Also, fitting a three-speed motor in the space within the inner shaft could present a formidable problem. Slowing to latch would increase the in-haul and pay-out time by only 30 seconds. This could be reduced, depending upon the accuracy of the footage or drum rpm counter employed.

Full speed latching could possibly be accomplished; however, this was not tried since full speed latching was not in the specification, and the latching at more than half-speed was observed to be quite noisy.

During the no-load and load test, gear case temperature increases over ambient of 71 and 80°F respectively, were recorded. This was after continuous operation through each phase of the test, with only air convection cooling. The gear case oil used does not break down until 180°F. Main shaft bearings temperature increased a maximum of 18 and 26°F over ambient during the no-load and load test.

The difference of "actual" and "total" horsepower in Table 3-1 should approximate the increase in frictional loss from the no-load to the loaded condition. Thus, the "actual" horsepower should always be greater than the "total" horsepower. The minor discrepancies observed in the table may represent inaccuracies in the measurement technique or reductions in friction due to run-in. It was noted during the no load test that a pronounced run-in period was required to smooth up the threads. After this period a lower hydraulic pressure was required. A similar phenomena may be taking place under increasing load. Also partition of the load between the recirculating ball bearing and the drum flange thread could cause variations in the required horsepower.

When the cable shifted from one drum to another, motor pressure increases or decreases, dependent on direction, could be detected. These pressure changes translate into horsepower demands of 1.3 and 2.5 for half load, and 2 and 4.4 for full load, half and full speed respectively. Also the change in pressure could be noted when the drum traversed up the 10° incline. Approximately one third horsepower was required under no load to traverse the drum.

## SECTION IV CONCLUSIONS AND RECOMMENDATIONS

From the results of the land-based test it can be concluded that the SCAT winch represents a promising high density storage device for handling a sectionally faired cable for a remote submerged application. The operational characteristics of the mechanical elements and the adequacy of the drive system to meet the design load, speed and brake objectives were demonstrated.

Since the winch was tested without its intended motor and controller, it is recommended that these items be procured, integrated and tested. The winch would then be ready for tests with the intended faired towline. In order to provide an entire system, the ancillary equipment, i.e., nest, hoist, towing-sheave, etc., must be developed. Also the integration of the new components into the BIAS control system must be undertaken.

Since a synthetic ball with the required characteristics for SCAT winch application is not readily available, it is recommended that additional research be conducted to develop a suitable ball. It is also recommended that full-speed latching be investigated if winch control becomes a problem.

## SECTION V REFERENCES

1. "Integrated Submarine Communications Antenna System," (U), Naval Ship Systems Command, Technical Development Plan S32-03, April 1969 (CONFIDENTIAL)
2. Dillon, D. B., (Classified Title)  
Hydrospace Research Technical Report No. 287, April 1970 (CONFIDENTIAL)
3. Dillon, D. B., "Functional Mock-Up of a Fairied Cable Handling System: Test Report," (U), Hydrospace Research Technical Report No. 266, 24 December 1969 (CONFIDENTIAL)
4. "SCAT RM Winch Development Program Phase I Design Study," Western Gear Corporation, S/O 31352, 22 October 1971
5. Vickers Industrial Products Catalog page i-38

APPENDIX A

RFP #71-355-900

A-1

**HYDROSPACE RESEARCH CORP. REQUEST FOR PROPOSAL NO. 71-355-900**

**1.0 GENERAL**

**1.1 TYPE OF CONTRACT**

It is intended that a Firm Fixed-Price contract will be negotiated as a result of this solicitation. Proposals shall, therefore, be responsive to this type of contractual arrangement.

**1.2 TERM OF CONTRACT**

The term of contract shall be for a period of four (4) months beginning on or about June 25, 1971.

**1.3 REQUEST FOR FURTHER INFORMATION**

Requests for further information concerning this RFP shall be made in writing or telephoning only to the Subcontracts Administrator, Mr. Steven Asc Hydrospace Research Corporation, 2150 Fields Road, Rockville, Maryland 20850, telephone: Area Code (301) 948-4350.

**1.4 PROPOSAL DUE DATE**

Proposals must be submitted on or before close of business on June 11, 1971 (4:00 P.M. EDT) prepared as outlined in Paragraph 2.0 "Instructions to Offerors".

**1.5 REJECTION OR ACCEPTANCE OF PROPOSAL**

It is the policy of Hydrospace Research Corporation to solicit proposals only where there is a definite intention to award a contract. Such policy notwithstanding, HRC reserves the right to reject all proposals submitted in response to this RFP; provided that, in the opinion of the Subcontracts Administrator, award of a contract would not be in the best interest of the Company. HRC reserves the right to make an award without discussion of the proposal.

## **1.6 TREATMENT OF TECHNICAL DATA**

The proposal submitted in response to this request may contain technical data which the offeror, or his subcontractor offeror, does not want used or disclosed for any purpose other than evaluation of the proposal. The use and disclosure of any such technical data may be so restricted; provided the offeror marks the cover sheet of the proposal with the following legend, specifying the pages of the legend:

Technical data contained in pages \_\_\_\_\_, of this proposal shall not be used or disclosed, except for evaluation purposes, provided that if a contract is awarded to this submitter as a result of or in connection with the submission of this proposal, HRC shall have the right to use or disclose this technical data to the extent provided in the contract. This restriction does not limit the HRC's right to use or disclose technical data obtained from another source without restriction.

HRC assumes no liability for disclosure or use of unmarked technical data and may use or disclose the data for any purpose.

## **1.7 PROPOSAL COST**

This Request for Proposal does not commit or obligate HRC to pay any costs incurred in the submission of the proposal or in making necessary studies or designs for the preparation thereof, nor to procure or contract for services or supplies.

## **1.8 SECURITY CLASSIFICATION**

The Statement of Work and attachment set forth herein are unclassified and proposals should be submitted accordingly. Contractor personnel may require access to higher classified documents; therefore, the selected contractor must possess or be able to acquire a Secret "Facility Security Clearance". Security clearance, for those persons required to have

such, will be obtained in accordance with the Industrial Security Manual for Safeguarding Classified Information (Attachment to DD Form 441), DOD Manual 5220.22.

**1.9 SUBMISSION OF PROPOSALS**

All copies of the proposals and all information requested pertaining to this RFP must be properly wrapped to prevent premature opening. The proposal must be addressed to arrive in the designated office as follows:

Hydrospace Research Corporation  
2150 Fields Road  
Rockville, Maryland 20850

Attention: Mr. Steven Asch  
Subcontracts Administrator

**1.10 EXECUTED CONTRACT TO CONSTITUTE ENTIRE AGREEMENT**

In the event of contract award, the definitive contract will constitute the entire agreement of the parties and will supersede any representations, commitments, conditions or agreements made orally or in writing prior to execution of the contract.

**1.11 PERSONS AUTHORIZED TO NEGOTIATE**

Included in your quotation or cover letter should be the name or names (and titles) and telephone numbers of individual(s) who are authorized to conduct negotiations. Cognizant technical personnel should also be listed.

Proposals must be signed by an official authorized to bind the offeror and shall contain a statement to the effect that the proposal is firm for a period of sixty (60) days from date of receipt by HRC.

## **2.0 INSTRUCTION TO OFFERORS**

### **2.1 GENERAL**

The performance specifications for this procurement have been tailored to permit the maximum possible latitude available with current technology to meet the requirements of the subject equipment. Consistent with this approach, minimum requirements have been specified in terms of the overall performance envelope with interfaces and constraints being called out only when necessary.

This RFP is for Phase I of a three-phase procurement for the Research Model Winch (RMW). Phase II will include the detailed design, fabrication and assembly of the RMW. Phase III will include the procurement of hardware and support services for a developmental test and evaluation program.

It is expected that the technical proposals submitted in response to this RFP will define in some detail the design approach proposed to implement the overall performance requirements and goals. The proposal will be evaluated on the basis of the relative suitability of the proposed approaches as well as on the credibility of the performance schedule, prices and estimates made by the offerors. The contract to the successful offeror for Phase I will invoke not only the general performance requirements specified in the initial bid package, but may also invoke additional characteristics defined in the offeror's proposal. The Phase II hardware contract will invoke design specifications which are generated during the Phase I effort.

### **2.2 OUTLINE OF THE PROPOSAL**

Offerors shall prepare their proposals in accordance with the following outline: (Each item a-d shall be bound together.)

- a. Transmittal Letter
- b. Technical Proposal
- c. Business Management Proposal
- d. Cost Proposal

Five (5) copies of the proposal are required for evaluation purposes.

#### **2.2.1 Transmittal Letter**

The transmittal letter is to be prepared on the responding company's letterhead. Its sole purpose is to document the submission of the proposal. Therefore, it should be brief and signed by an individual who is authorized to commit the company to the extent of work proposed.

#### **2.2.2 Technical Proposal**

No detailed outline for the contents of the technical proposal is specified. However, the technical proposal should indicate clearly the offeror's understanding of the problem, the scope of the effort involved, and should reflect his approach to implementing each of the contractor tasks specified in the Statement of Work. Pertinent prior experience and relevant corporate capability should be addressed. Resumes of key technical personnel should be included.

#### **2.2.3 Business Management Proposal**

The offeror's proposal should reflect clearly his business management plan for controlling the performance of any contract or follow-on effort which may result from this RFP. The proposal should include organization charts showing separately and interrelating the company and the project organization in this effort. Cover company organization from the executive vice president level to the first line of supervision and include technical, manufacturing, quality assurance and administrative organizations. The project leader must be identified and a description given of his authority and his accessibility to top management.

The offeror should describe his internal procedures for controlling his schedules including a description of the level of detail to which he will use schedule control techniques. The offeror should also describe his internal procedures for controlling costs. Progress reporting is to be accomplished as required by the statement of work. The offeror should include in his proposal the depth of activities he intends to cover and the timeliness of the reports.

#### **2.2.4 Cost Proposal**

The Cost Proposal shall be divided into two sections. The first section shall be a firm fixed-price quote for the execution of the Phase I effort and shall contain sufficient backup and detail to allow evaluation. The second section shall contain a detailed budgetary cost estimate for execution of the Phase II effort and should be presented in sufficient detail to allow a reasonable cost evaluation.

#### **2.3 PROPOSAL EVALUATION**

A proposal evaluation committee made up of members of the HRC staff will be established. However, FRC reserves the right to conduct its evaluation in concert with Government personnel if this is deemed to be in the best interest of the overall program.

#### **2.4 EVALUATION CATEGORIES**

Technical proposals will be evaluated against criteria established under the following categories, with each category given the indicated relative weighting:

Category 1 - Technical Approach (45%)

Category 2 - Corporate Capability and Experience (20%)

Category 3 - Business Management (10%)

Category 4 - Project Personnel (15%)

Category 5 - Cost (10%)

### **3.0 STATEMENT OF WORK**

#### **3.1 INTRODUCTION**

The Naval Ship Research and Development Center (NSRDC) is presently involved in a program to design, fabricate and test a faired cable handling system. Hydrospace Research Corporation (HRC) has completed a study program for NSRDC, which identified the type and scope of faired towline, which necessitated the use of a multi-layer concentric drum winch to handle the faired towline.

HRC, under contract to NSRDC, is now undertaking a development program for a RMW portion of the system. Phase I encompasses the determination of technological feasibility of the concept. Phase II of the program would include the detail design, fabrication, assembly and checkout. Phase III will include the demonstration of operational feasibility.

#### **3.2 PURPOSE**

This Request for Proposals is a solicitation for a technical study for Phase I. The study is to address three areas:

- (1) the technical feasibility of the concept,
- (2) the preliminary design of a RMW, and
- (3) the preparation of a program plan to implement the detailed design and construction of a RMW.

#### **3.3 GENERAL BACKGROUND**

Theoretical analyses performed by HRC show the need for full cable fairing in order to provide the required performance. Attachment A presents a detailed description of the concept for the RMW. The salient requirements of the winch are that it:

- (1) handle faired cable,
- (2) be submersible,
- (3) operate by remote control, and
- (4) be highly compact.

In order to satisfy these requirements, the concept is based on the use of:

- (1) multiple drums,
- (2) concentrically nested on a common shaft, and
- (3) traversing axially along the shaft axis for level winding.

This concept is summarized by the acronym - Submersible, Concentric, Axially Traversing (SCAT) winch.

### 3.4 CONTRACTOR TASKS

During the Phase I study the contractor will perform the following tasks.

#### 3.4.1 Conduct Preliminary Design

This will require the translation of the concept into preliminary hardware design. Involved will be layout drawings in sufficient detail for identification of components clearly, and the design calculations required to assure the adequacy of the design approach from the analytical standpoint. These calculations at a minimum should include stress, weight, power, control, and dimensional tolerance.

### **3.4.2 Evaluate Technical Feasibility**

This would be an ongoing effort during 3.4.1 in which alternate approaches, within the confines of the concept defined in Paragraph 3.3, would be traded off based upon reliability, producibility, cost, etc. However, a preferred design with the highest probability of success would be the output of the effort.

### **3.4.3 Identify Critical Components**

An important part of the study effort will be the early identification of critical components whose functional feasibility or reliability may be in doubt. An example might be the driving/latching mechanism that selects the proper drum for spooling and maintains the proper alignment of the others. Early identification of these components is essential in order that a concurrent testing program may be instituted if required. Component development would be funded separately if deemed necessary in this phase of the program. Critical component developmental testing would allow the following:

- (1) selection between alternate component approaches,
- (2) establishment of component feasibility, and
- (3) improvement of component reliability

### **3.4.4 Identify Interface Requirements**

In order to be integrated into an appropriate sea-going testbed, all interface requirements for the RMW must be identified. At a minimum this would include power, envelope and weight. HRC will be responsible for system integration, but will rely on input from the contractor for interface refinements and options.

### **3.4.5 Prepare Proposal for Phase II**

If the overall technical feasibility evaluation is affirmative, the groundwork for Phase II shall be laid by the preparation of a proposal for

the design, construction, and factory checkout of a SCAT winch. This proposal will summarize the study in the form of a specification for the SCAT winch. It would establish schedules and cost information for detailed design engineering procurement, manufacturing, and land-based checkout testing. The schedules would identify long-lead time components due to procurement and development. This proposal should be a firm fixed-price quote which should remain in effect for 90 days.

Also, this proposal shall include a management plan which will indicate how Phase II would be structured within the overall corporate management. It should indicate (but not necessarily be limited to) the mechanisms controlling procurement of materials, production of machinery, and protection of quality.

#### 3.4.6 Project Control and Reporting

3.4.6.1 Meetings - Five (5) meetings between representatives of the Contractor, HRC, and NSRDC will be held during the course of the contract period. Two shall be held at the Contractor's facility; three at HRC-Rockville. The first meeting will be held at the HydroSpace facility for the purpose of contract commencement. The second meeting will be approximately three (3) weeks later, for the purpose of discussing critical components and testing. The third meeting will be approximately six (6) weeks later, for the purpose of reporting the results of the component tests. A preview of the final report will be presented two weeks before the end of the contract period. The fifth meeting will include the delivery of the final report at the end of the contract period. Meetings may be omitted or additional meetings included as necessary and agreed upon.

3.4.6.2 Final Report - The contractor shall prepare and deliver five (5) copies of a final engineering report which documents program efforts and activity from

inception. This report shall contain as a separate volume the proposal for Phase II. All information derived under the above tasks which are not included in the Phase II proposal shall be included in the final report. This may include but not necessarily be restricted to:

- a. Engineering drawings and diagrams
- b. Design calculations
- c. Detailed philosophy of equipment
- d. Discussion of system capabilities and shortcomings.

With the exception of the design of proprietary components included in the RMW, the concepts and drawings prepared for this study shall become the property of the United States Government. A design, process, material, concept or the like may not be claimed as proprietary if it was first conceived and/or developed or reduced to practice under this contract.

#### **4.0 GOVERNMENT PROPERTY**

HRC will not provide any Government-owned property for the performance of the work hereunder. If an offeror intends to utilize Government property in the performance of this work, he should include in his proposal a schedule of the property to be utilized indicating its estimated cost, estimated usage, and his authority to so utilize.

#### **5.0 TERMINATION FOR CONVENIENCE.**

The performance of work under this subcontract may be terminated in whole or in part, whenever HRC shall determine that such termination is in its best interest. Termination of work hereunder shall be effected by delivery to the Subcontractor of a written Notice of Termination, specifying the extent to which performance of work is terminated and the date upon which such termination becomes effective. Upon receipt of a Notice of Termination, the Subcontractor shall stop work to the extent the termination notice specifies and place no further order or subcontracts for material, services, or facilities, except as may be necessary for completion of such portion of the work under the contract as is not terminated. The Subcontractor then must submit to HRC its termination claim, in the form and with the certification prescribed by HRC. Such claim shall be submitted promptly and never beyond six months from effective date of termination.

A complete inventory list of the fabricated or unfabricated parts, work in process, completed work, supplies, and other material produced as a part of, or acquired in respect of performance of, the work terminated by the Notice of Termination shall be submitted along with the termination claim. This material shall be available for transfer of title to HRC in the manner, to the extent, and at the time as directed by HRC.

Upon failure of the Subcontractor to submit its termination claim within the time allowed, HRC may determine, on the basis of information available to it, the amount, if any, due the Subcontractor in respect to the termination and such determination shall be final.

## **6.0 GENERAL PROVISIONS**

**ASPR Fixed-Price Research and Development Contracts clauses:**

**7.302.1 through 7.302.29**

**Also 7.303.2, 7.303.3, 7.303.4, 7.303.7, 7.303.9, 7.303.10,  
7.303.12, 7.303.15, 7.303.16, 7.303.26, 7.303.27, 7.303.28,  
7.303.29, 7.304.1.**

**Any other clauses required by law or regulations.**

## **7.0 Each offeror should complete and/or comply with the attached:**

- 1. Pre-award Patent Right Documentation DD1564**
- 2. Certification of Non-Segregated Facilities**
- 3. Affirmative Action Program/EEO Reporting**
- 4. Supplier Questionnaire**
- 5. Contingent Fee Representation**
- 6. Buy American Certification**

**NOTICE TO PROSPECTIVE SUBCONTRACTORS OF REQUIREMENT FOR  
CERTIFICATION OF NON-SEGREGATED FACILITIES**

A Certification of Non-Segregated Facilities, as required by the May 9, 1967, Order On Elimination of Segregated Facilities, by the Secretary of Labor (32 Fed. Reg. 7439, May 19, 1967), must be submitted prior to the award of a subcontract exceeding \$10,000 which is not exempt from the provisions of the Equal Opportunity Clause. The Certification may be submitted either for each subcontract or for all subcontracts during a period.

Subcontractor/Vendor shall sign and return one (1) copy of this certification to:

Hydrospace Research Corporation  
5541 Nicholson Lane  
Rockville, Maryland 20852  
Attention: Purchasing Department

**CERTIFICATION OF NON-SEGREGATED FACILITIES**

By the submission of this bid, the bidder, offeror, applicant, or subcontractor certifies that he does not maintain or provide for his employees any segregated facilities at any of his establishments, and that he does not permit his employees to perform their services at any location, under his control, where segregated facilities are maintained. He certifies further that he will not maintain or provide for his employees any segregated facilities at any of his establishments, and that he will not permit his employees to perform their services at any location, under his control, where segregated facilities are maintained. The bidder, offeror, applicant, or subcontractor agrees that a breach of this certification is a violation of the Equal Opportunity Clause in this contract. As used in this certification, the term "segregated facilities" means any waiting rooms, work areas, rest rooms, and wash rooms, restaurants, and other eating areas, time clocks, locker rooms and other storage or dressing areas, parking lots, drinking fountains, recreation or entertainment areas, transportation, and housing facilities provided for employees which are segregated by explicit directive or are in fact segregated on the basis of race, creed, color, or national origin, because of habit, local custom or otherwise. He further agrees that (except where he has obtained identical certifications from proposed subcontractors for specific time periods) he will obtain identical certifications from proposed subcontractors prior to the award of subcontracts exceeding \$10,000 which are not exempt from the provisions of Equal Opportunity Clause; that he will retain such certification in his files; and that he will forward the above notice to such proposed subcontractors (except where the proposed subcontractors have submitted identical certifications for specific time periods).

(NOTE: The penalty for making false statements in offers is prescribed in 18 U.S.C. 1001).

This Certification shall be valid for a period of twelve months from the date below.

---

Name of Vendor

---

Signature

---

Date

Purchase Order No. \_\_\_\_\_

---

Typed Name

Attachment No. 1

---

Title

**Affirmative Action Compliance Programs and Equal Opportunity Reporting Requirements (applicable to orders amounting to \$50,000 or more if the seller has 50 or more employees.)**

**1. Affirmative Action Program**

- a. Paragraph 60-1.40 of the rules of the Office of Federal Contract Compliance stipulate that each prime contractor and subcontractor shall require each subcontractor who has 50 or more employees and a subcontract of \$50,000 or more to develop a written affirmative action compliance program for each of its establishments. Within 120 days from the commencement of the contract, each subcontractor shall maintain a copy of separate affirmative action compliance programs for each establishment, including evaluations of utilization of minority group personnel and the job classification tables, at each local office responsible for the personnel matters of such establishment. An affirmative action compliance program shall be part of the manpower and training plans for each new establishment and shall be developed and made available prior to the staffing of such establishment. A report of the results of such program shall be compiled annually and the program shall be updated at that time. This information shall be made available to representatives of the agency or Director upon request and the subcontractor's affirmative action program and the result it produces shall be evaluated as part of compliance review activities.

**2. Equal Employment Opportunity Reporting**

- a. Seller will complete and file Government Standard Form 100, Equal Employment Opportunity Employer Information Report EEO-1, in accordance with the instructions contained therein.
- b. Notification of compliance with the above requirement shall be furnished to Buyer, by letter or by execution of Supplier Data Card (HRC P-1).

## PRE-AWARD PATENT RIGHTS DOCUMENTATION

Form Approved  
Budget Bureau No. 22-R262

## PROCUREMENT IDENTIFICATION

## STATUS OF PROSPECTIVE CONTRACTOR

1. CONTRACTOR IDENTIFICATION  
 2. COMPANY NAME

B. DIVISION NAME (If any)	C. ADDRESS (Number and Street, City and State or Country) (Include Zip Code)
---------------------------	--

## CHECK APPLICABLE BLOCK

YES NO

2. a. IS OFFEROR A MANUFACTURER OR SOURCE OF PRODUCTS OR SERVICES IN AN AREA DIRECTLY RELATED TO A FIELD OF TECHNOLOGY WHICH INCLUDES THE WORK CALLED FOR UNDER THIS REQUEST? (See ASPR 9-107.3(b) and 9-107.4(c)(1)(i)).

b. IS OFFEROR REGULARLY ENGAGED IN THE SALE OR LICENSING OF SUCH PRODUCTS OR SERVICES (See ASPR 9-107.3(b) and 9-107.4(c)(1)(ii)) TO:

- (1) THE U. S. GENERAL PUBLIC (including business concerns)?
- (2) THE U. S. GOVERNMENT?
- (3) FOREIGN GOVERNMENTS?
- (4) FOREIGN NATIONALS (including business concerns)?

c. HAS OFFEROR DEVELOPED NONGOVERNMENTAL COMMERCIAL MARKETS FOR INVENTIONS IN AN AREA DIRECTLY RELATED TO THE FIELD OF TECHNOLOGY WHICH INCLUDES THE WORK CALLED FOR BY THIS PROCUREMENT? (See ASPR 9-107.3(b) and 9-107.4(c)(1)(iii)).

d. IF THE ANSWER TO 2c. ABOVE IS "YES", EXPLAIN BRIEFLY.

3. IS OFFEROR AN EDUCATIONAL OR NONPROFIT INSTITUTION (See ASPR 9-107.4(c)(2)(i))?

4. IF NOT AN INSTITUTION UNDER ITEM 3, IS OFFEROR EITHER:

a. A "NEWLY FORMED" RESEARCH AND DEVELOPMENT ORGANIZATION?

b. A "NEW" INDEPENDENT RESEARCH AND DEVELOPMENT DIVISION OR A SUBSIDIARY OF AN OLDER ORGANIZATION? (See ASPR 9-107.4(c)(1)(i)).

NOTE: An organization under Item a or division or subsidiary under Item b established more than 3 years shall NOT be considered "newly formed" or "new".

5. IF THE ANSWER TO ITEM 4a OR b IS "YES", DOES OFFEROR HAVE A DEFINITE PROGRAM FOR ESTABLISHING A NONGOVERNMENTAL COMMERCIAL POSITION WHICH MAY BE DEPENDENT ON THE PROTECTION AFFORDED BY TITLE TO INVENTIONS LIKELY TO RESULT FROM THIS PROCUREMENT? (See ASPR 9-107.4(c)(2)(ii)).

IF THE ANSWER TO ITEM 5 ABOVE IS "YES", EXPLAIN BRIEFLY.

TYPED NAME AND TITLE

SIGNATURE OF PERSON COMPLETING THIS FORM

## TO BE COMPLETED BY CONTRACTING OFFICE

Patent Rights (License) Clause, ASPR 9-107.5(b) [ ] , Patent Rights (Deferred) Clause, ASPR 9-107.5(c) [ ]. Will be used in the solicitation and resulting contract. (Give reasons for determination.)

TYPED NAME AND TITLE

SIGNATURE OF CONTRACTING OFFICER OR REPRESENTATIVE

DD FORM 1 JUN 66 1564

## SUBMERSIBLE WINCH FOR SECTIONALLY FAIRED CABLE

### A.1 APPLICATION

When objects, such as instrument-carrying "fish," are towed at sea, it is usually desired to provide a transverse separation so that the instruments are not in the wake of the towing vessel. The hydrodynamic drag on the towcable has a strong influence on the separation that can be attained. As towing speeds increase, increasingly sophisticated methods of drag reduction must be employed. The present program seeks to develop a winch for handling a sectionally faired cable from a submerged platform.

### A.2 SPECIFICATIONS

Table A-1 is a summary of the following specifications.

#### A.2.1 Cable

The towline is a double-armored electro-mechanical cable. Slip rings (or equivalent) for 10 leads are required on the handling system. The cable diameter is nominally 0.35 inches. Storage capacity for about 1400 feet is needed.

#### A.2.2 Fairing

A sectional fairing is to be applied along the towline. The fairing increases the effective cable diameter to about 0.5 inches. The fairing has a chord of 2.5 inches. Each section is about 2 inches long. Deep grooves on sheaves and drums are required to ensure that the fairing spools properly without warping to either side.

#### A.2.3 Winch

##### A.2.3.1 Speed

The winch power and gearing must provide for a 150 feet/minute fast speed for retrieving and deployment of large segments of cable. A slow

TABLE A-1

SUMMARY OF COMPONENT PERFORMANCE SPECIFICATIONS

Component	Parameter	Value	Unit
Cable	Diameter	0.35	feet
	Length	1400	inches
	Leads	10	----
Fairing	Type	Sectional	-----
	Diameter	0.50	inches
	Chord	2.5	inches
	Length/Section	2.0	inches
Winch	Drum Type	Grooved	-----
	Speed, fast	150	ft/min
	Speed, slow	50	ft/min
	Speed, creep	15	ft/min
	Tension, Hauling	5600	lbs.
	Tension, Brake	14000	lbs.
	Pressure, Water	1000	psi.

speed of about 50 feet/minute is necessary for launching and nesting the towed body. In addition, a 15 feet/minute creep speed may be required to facilitate the transfer of cable from one drum to another and the associated operations.

#### A.2.3.2 Tension

A maximum hauling load of about 5600 pounds is necessary, with a braking capacity of 14,000 pounds.

#### A.2.3.3 Pressure

The winch must withstand hydrostatic pressure of 1000 psi without harm due to mechanical stresses, fluid contamination or the like.

#### A.2.3.4 Size

This requirement is of overriding importance to virtually all of the preceding specifications. The winch volume must be entirely contained within the envelope indicated by the accompanying drawings. Only the most cogent reasons can be considered for exceeding this envelope.

### A.3 CONCEPT

Sheet 1 shows a preliminary concept of a four-drum winch capable of storing approximately 1400 feet of faired .35-inch electromechanical cable. The bottom half of the drawing shows the relative positions of the four drums when all 1400 feet have been deployed; the top half indicates the fully loaded configuration. The cable is deployed from the bottom of the drums, in the mid-plane of the winch, "out of the back of the paper." Thus, on deployment, the drum sections in the top of the drawing may be visualized as coming up out of the paper, while the bottom sections move down into the paper.

#### A.3.1 Function

Before discussing in detail the concept expressed by the accompanying drawing (71355001), it will be well to describe the overall functional concept of operation.

### A.3.1.1 Retrieval

When all the cable is paid out, the four drums are "staggered" as shown in the bottom of Sheet 1. The inner drum is keyed to the central mainshaft, but free to slide along it axially. The second drum is rigidly fixed to the left end-frame of the winch by a latch. The third drum is similarly fixed to the right end, while the outer drum is fixed at the left end.

At the center-plane of the winch, slots have been cut in the second, third, and fourth drums. These slots are aligned so that the faired cable has access to the inside drum. The alignment of these slots is shown on the right-hand sketch of Sheet 2. The relation of the sketch to Sheet 1 may be visualized by imagining the sketch held with its printed side to the left and the cable "rays" pointing down the center plane of Sheet 1.

Turning drum 1 on retrieval hauls cable in through the slots in the outer three drums and onto the groove in drum 1, which is fleeted to the left to keep its grooves aligned with the slot. As the last turn of drum 1 is made, the groove spirals up the right-hand flange, as shown on the left sketch of Sheet 2. At this point, drum 1 has moved to the left until it is directly inside drum 2, which has been fixed to the left frame until now.

When the cable spirals up the last groove on drum 1, drum 2 is unlatched from the frame and latched to drum 1, which causes it to rotate with drum 1. The edge of the slot in drum 2 mates with the ramped groove in drum 1, and the cable commences to wind on drum 2, which is fleeted to the right in order to keep its grooves in alignment with the slots in drums 3 and 4.

Drums 1 and 2 fleet together past the slot in the center-plane of the winch, until the last turn of the cable grooves in drum 2 is reached, as the two drums reach the right end of their travel, directly under drum 3. The last cable groove in drum 2 spirals up the flange as before, except that it is the left flange.

A similar latching operation takes place, along with a fleeting reversal, and the cable commences to wind onto grooves in drum 3, and finally, on drum 4, the outer drum. When the cable has all been retrieved, the drums are all nested and stacked as shown in the upper half of Sheet 1.

#### A:3.1.2 Deployment

Deployment requires a reversal of the retrieving operations. Cable is veered from the outermost drum (4) through a slot in the cover, while the four drums, nested and stacked are fleeted to the left across the mainshaft. When drum 4 is empty, it engages a latch and is fixed to the left end frame, while the inner 3 drums are released from the outer drum and continue to rotate. The slot in the outer drum aligns with the slot in the cover.

Cable is veered from drum 3, which is fleeted with drums 1 and 2 to the right, and so on, until all the cable is veered and the configuration shown on the bottom half of Sheet 1 is attained.

With the functional concept in mind, the details of the mechanisms used may be discussed.

#### A.3.2 Drive

The prime mover indicated for the winch is a high-torque hydraulic motor mounted on the lower left corner of the winch frame at "A". A 14-tooth pinion on the motor drives a 35-tooth sprocket on the winch mainshaft by way of a large roller chain. The mainshaft is indicated as a 13-inch I.D. tube supported by ring bearings at each end. An appealing alternative is to locate the prime mover (electric?) within the considerable volume of the mainshaft tube. Preliminary evaluations indicate that there are non-trivial problems in packaging the desired torque and power within this envelope.

Sheet 1 shows an end view of the mainshaft and the four concentric drums. Four square-cornered "ways" are fixed to the mainshaft and transfer torque through way-blocks on the inside of the central drum. Torque

is transmitted from one drum to the next outer drum only when they are exactly nested with their ends flush together, through "steps" that extend from the drum flanges.

Sheet 3 shows details of the flange geometry. The unshaded part of section A-A is the step on the left flange of drum 1 that drives drum 2. If A-A is imagined to be "turned-over" (i. e. backside up) and placed at location 1A on Sheet 1, the engagement of the step with drum 2 can be visualized.

Section B-B on Sheet 3 shows the mating part of drum 2. The unshaded portion to the left, similar in shape to the step on AA, will be discussed later; the unshaded tongue extending to the right is the step that is engaged by drum 1. As before, the figure must be reversed mentally and transposed to location 2A on Sheet 1.

In section A-A we are viewing the metal face of the step; the metal "extends" beneath the paper; in section B-B we view the face of the mating step from within the metal, which extends upward from the page towards us.

A similar pair of steps, in mirror image, are on the right-hand flanges to transmit torque from drum 2 to drum 3 as shown at 2B/3B on Sheet 1. Finally, a third set is used at 3A/4A on Sheet 1 to drive the outer drum.

When a drum is driven (turning), all drums inside are nested with it and turning together. In fact, not only are the steps engaged, but toggles latch the steps together so that the drums cannot overrun each other. Drums outside the "active" drum are fixed, latched to support rings at either end of the winch, alternately as shown at the bottom of Sheet 1.

#### A.3.3 Fleeting

Threads are turned on the inner surface of each drum as well as the outer jacket. Mating threads are turned on the periphery of the drum flanges. These threads alternate between right- and left-handedness. Since

the drum outside the "active" drum is fixed, as the active drum turns, it screws along the threads, whose pitch coincides with that of the fairing grooves, and slides along the ways on the mainshaft.

Following the rotation convention described above (A-3), it may be seen that a right-hand thread cut on the flanges of drum 1 and the inside of drum 2 will cause drum 1 to fleet to the left on retrieval (bottom half of Sheet 1), maintaining an "empty groove" in the center of the winch.

#### A. 3.4 Drum Supports

The inner drum is supported on the mainshaft through the ways and way-blocks. Whenever a drum is in rotation (i. e. under cable tension) it is supported at both ends by the flanges of the drums within it. Axial loads are restrained by the fleeting threads.

Whenever a drum is empty, it is cantilevered from either end frame by screwing the fleeting threads on its flanges into a mating ring on the end frame. Sheet 4 shows these rings. The rings have step faces to stop further rotation when the drum is fully engaged in the ring.

The ring for drum 2 is unique in that it must retract at a certain stage in the deployment/retrieval sequence, in order to allow the outer drum to fleet properly. Consider the deployment sequence beginning with the winch fully loaded as shown on the top half of Sheet 1. As the outer drum veers cable, it fleets to the left, driven by the left-hand threads in the inside of the cover. Drums 1, 2, and 3 are carried with it. As the outer drum nears the left frame, the support ring for drum 2 must retract in order to allow drum 2 to continue to fleet with drum 3.

The support ring is mounted on 7 retracting pins, shown on Sheet 5. A detailed drawing of one design is Detail "C" on Sheet 4. A base is bolted to the end frame, with a collar screwed into it. The retracting pin fits like a piston in the collar, with a heavy spring to eject the pin when the retraction is ended. The "business end" of the pin is

screwed into the support ring. A sensing rod is fitted down the center of the main pin. The sensing rod is ejected by a small spring in the base of the collar.

When the main pin is "out", it is latched by a ball-lock such as are used in quick-disconnect fittings: balls are caught in a raceway in the collar by a cone-shaped plunger on the sensing rod. If Drum 2 approaches its support ring while engaged with drum 3, the end of latter pushes against the sensing rod, which retracts the plunger, releasing the main pin. As fleeting continues, drum 3 bears on the support ring itself and pushes it in, out of the way of drum 2. The outer drum may then be latched or unlatched and fleeting reversed. As drum 3 moves to the right, the main spring ejects the main pin; then the plunger forces the balls back into the raceway, latching the ring.

If drum 2 approaches the support ring without drum 3, then nothing contacts the sensor pin and the ring remains fixed, so that the drum fleets onto its threads and is latched.

Stop faces, as described in part A. 3. 2, are appropriately positioned on the support rings and mating flanges to align the drum slots properly when the drums are supported from the rings.

#### A. 3. 5 Latches

The stop faces on the driving and support flanges control torque loads and maintain rotational alignment in one direction. Cam latches are installed in the flanges to maintain alignment against frictional torques.

Detail "C" on Sheet 3 shows a typical latch of this type. The latch has two arms, one of which releases as the other engages. Each arm has a sloping cam surface on one end and a locking end. An erection spring is mounted between the arms near the cam end. Let the inner arm (dashed lines over pivot) be called arm 1; the other, arm 2.

On inhaul, when drum 2 is cantilevered from the support ring, arm 1 engages the ring opposite the stop face, as drawn. Arm 2 is held retracted (not as drawn - rotated clockwise). The driving face of drum 1 approaches in a counter-clockwise sense as Detail "C" is viewed. It encounters the cam surface of arm 1 and forces it aside (counter-clockwise), swinging the latch end out of its notch in the support ring, unlatching drum 2 from the ring. When the driving face meets drum 2, both rotate together, and the latch arms are carried with drum 2 via the pivot pin.

When the cam surface of arm 2 clears the stop face on the support ring, arm 2 is swung counter-clockwise by the erector spring, and the lock end engages a notch behind the driving face of drum 1, latching drums 2 and 1 together.

If the winch is now reversed, to pay out, and there is not enough tension in the cable to overcome the fleeting friction and turn drum 2, drum 1 can now drive drum 2 through arm 2 and the pivot pin. Sheets 6 and 7 show the details of drums 3 and 4.

#### A. 3. 6 Electrical Leads

The concept illustrated here does not use slip rings, although a conventional slip ring assembly could easily be installed in the end of the mainshaft. Sheet 1 indicates the alternate concept which exploits the fact that the winch executes a finite number of turns in either direction.

A fixed mandrel is mounted on the left end-frame and extends into the hollow mainshaft. The conductors are conduited down the axis of the mandrel and connected to a "ribbon cable" of the type used in electrical chassis design. The end of the ribbon is fixed to the mandrel and wrapped around the mandrel like a spool of tape. The other end of the ribbon is fixed to the mainshaft.

As the mainshaft turns, a loop forms in the ribbon, and the layers of ribbon unwrap, reverse in the loop, and re-wrap in the opposite rotation. Since the ribbon is unwrapped ( $N$  turns) and rewapped ( $M$  turns) while the winch rotates  $M$  turns, it is easy to see that

only half as many ribbon lays as winch turns are needed.

The ribbon is passed through the mainshaft wall, along the mainshaft, around a spring-tensioned sheave to the cable termination block on the inside of drum 1. The spring-sheave controls the slack in the ribbon, while permitting drum 1 to traverse along the mainshaft during fleeting.

The natural stiffness of the ribbon wires may make the sheave unnecessary, or the ribbon might be formed into a zig-zag spring and stretched between the blocks on drum 1 and the mainshaft. In the latter event, the mandrel and spiral tape assembly would be mounted in the opposite end frame.

#### A.3.7      Variations

The drawings included in this Attachment represent the most recent interpretation of the SCAT concept by HRC, and should be sufficient to enable offerors to prepare a responsive proposal for this RFP. The interpretation presented here is by no means the unique solution, nor is it a complete solution to the SCAT winch problem.

Other interpretations have been developed at HRC and rejected for one reason or another. While it is premature to attempt to describe these at this time, they will be fully disclosed after the contract has been awarded.

It is assumed and desired that responders to this RFP will have considered the SCAT concept and this interpretation sufficiently that some suggestions for other interpretations will be included in their proposals. One of the primary motivations for releasing this RFP and the contract award is to obtain such reinterpretation.

#### A.4           STANDARDS

##### A.4.1        Materials

Although the statement of work does not include the construction of the SCAT winch, the federal QQ-series material specifications should be assumed to apply when developing cost data and selecting materials.

#### A. 4.2

##### Design

The following military specifications should be considered in developing the SCAT design:

- MIL-S-901 Shock, H. I. (High-Impact); Shipboard Machinery, Equipment and Systems, Requirements for.
- MIL-Q-9858 Quality Control System Requirements.
- MIL-E-16400 Electronic Equipment, Naval Ship and Shore; General Specifications.
- MIL-STD-167 Mechanical Vibrations of Shipboard Equipment.

While it is not anticipated that the RW model of the SCAT winch will be subjected to the tests related to the foregoing specifications, their inclusion at this time will avoid costly redesign on later models.

#### A. 4.3

##### Construction

MIL-STD-248 Qualification Tests for Welders will be applied during Phase II.

POTENTIAL WIDE-INTEREST REPORT

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WARNING TO EVALUATORS FROM INPUT

DOCUMENT WILL REPRODUCE POORLY

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2. Accepted as regular report \_\_\_\_\_  
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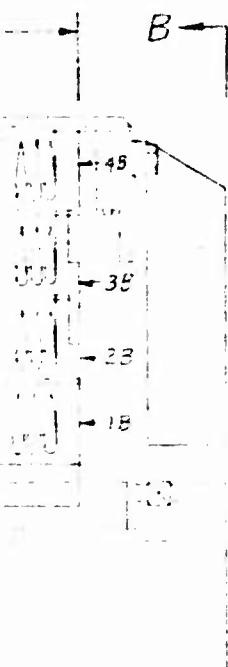
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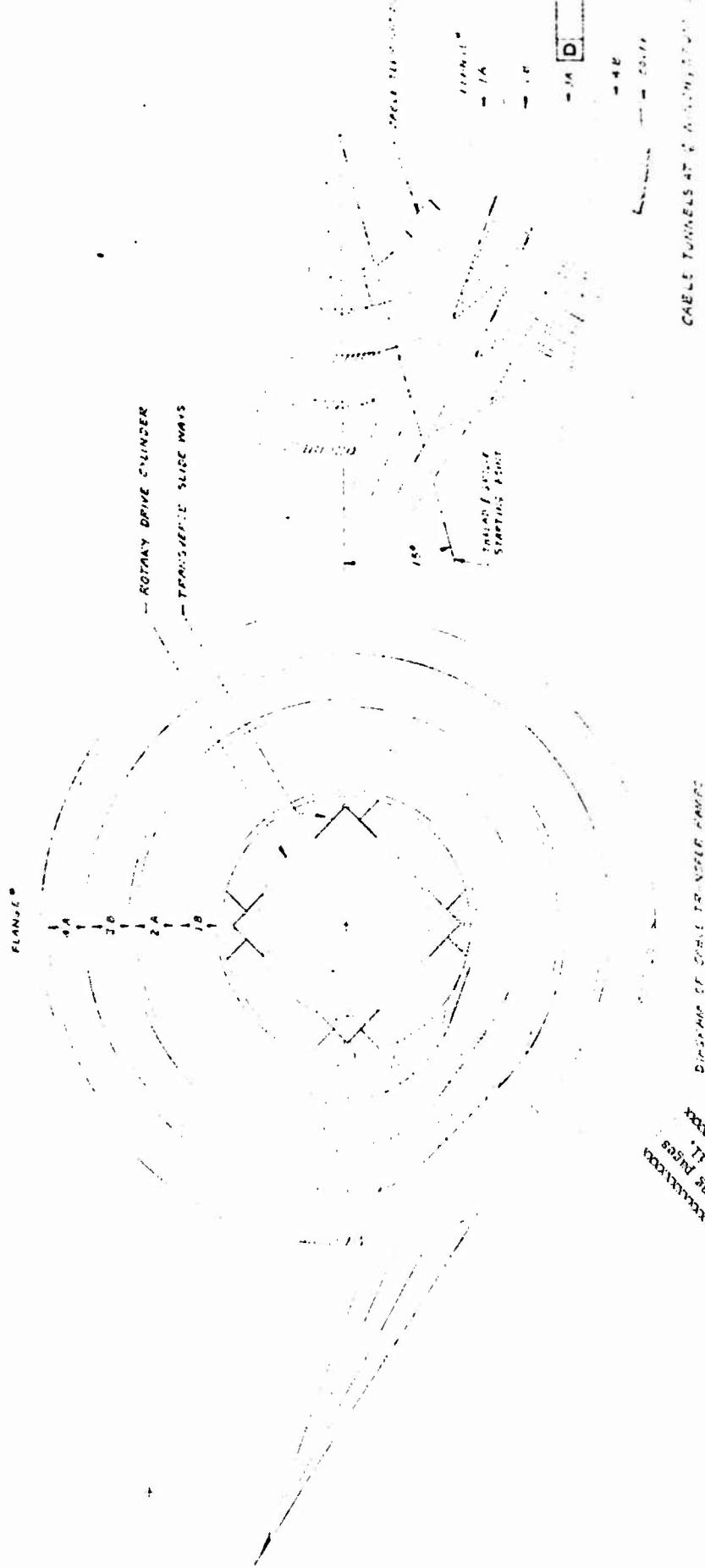
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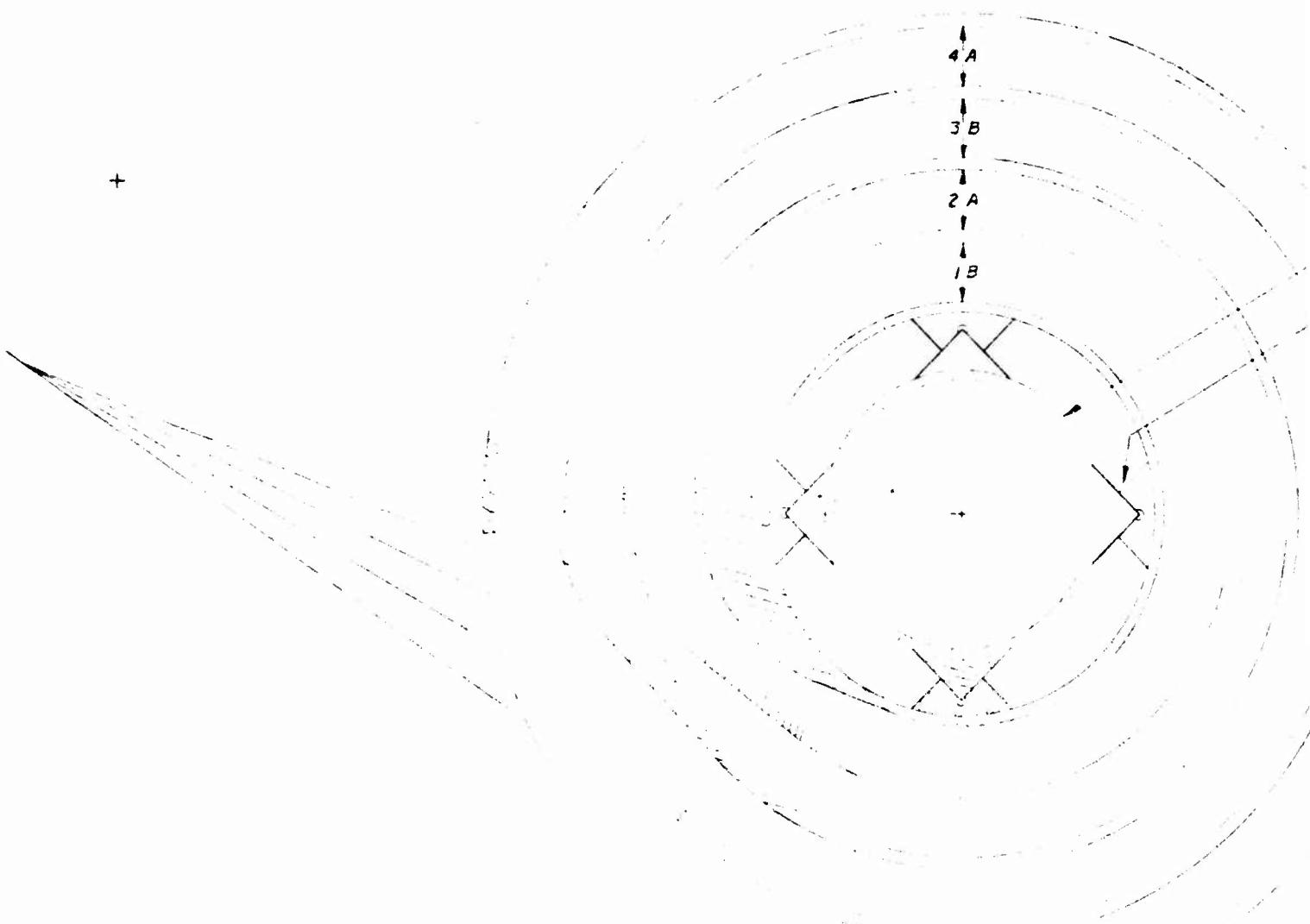


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*See the following pages for greater details.*

- 8 -

**FLANGE \***

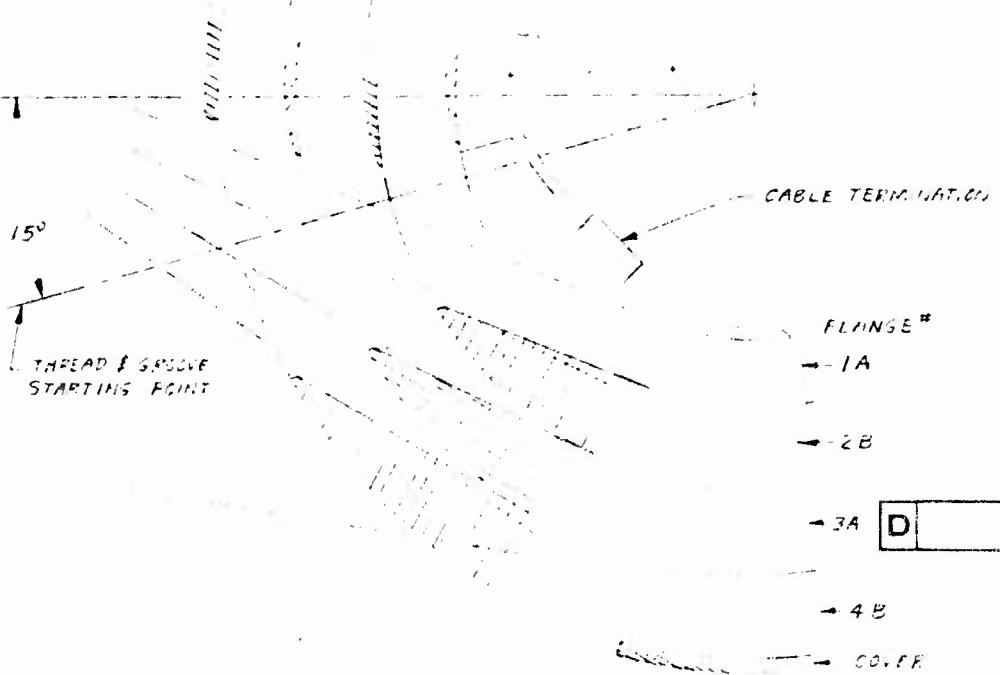


### DIGESTION OF SMALL TRANSFER FAMPS

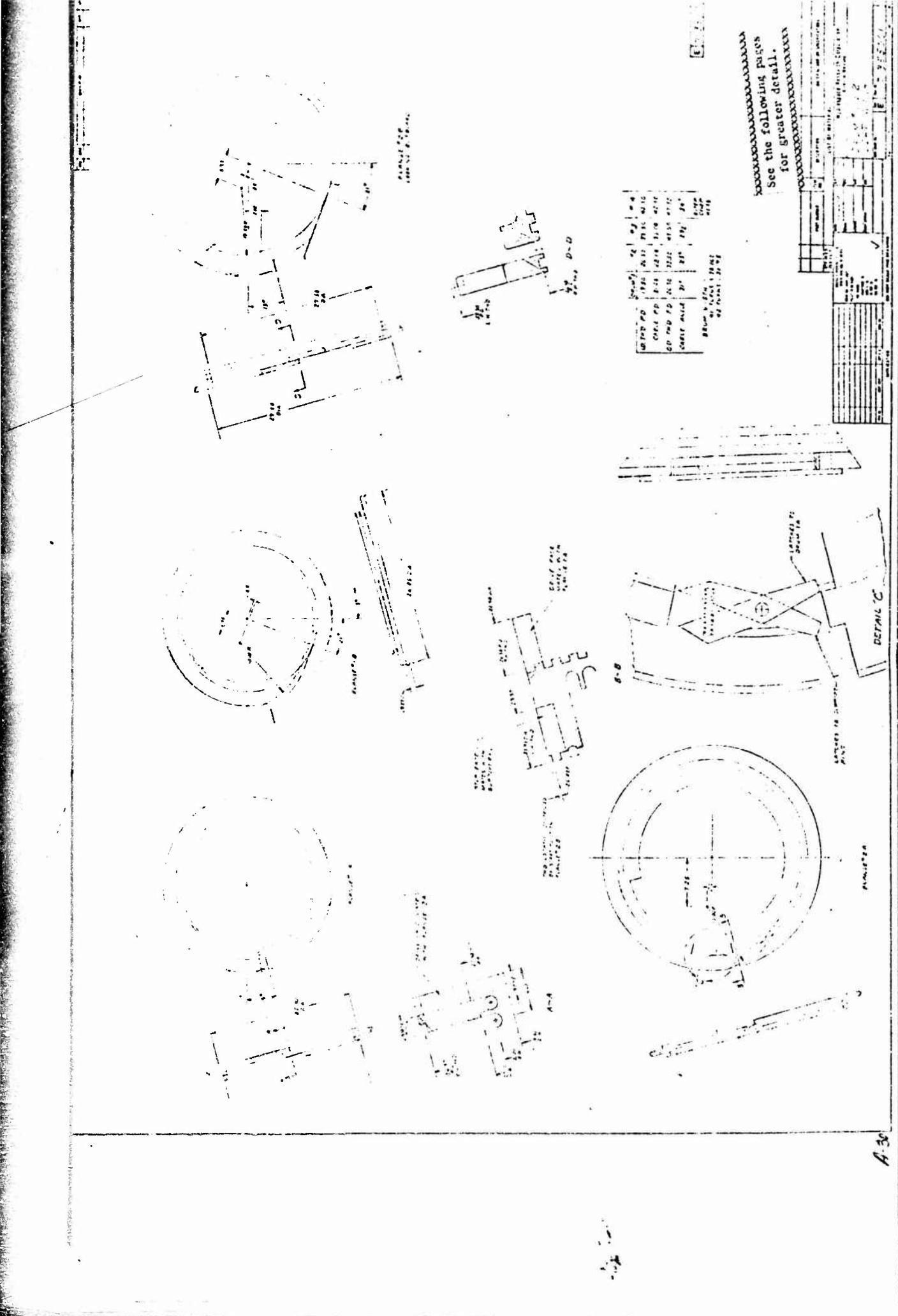
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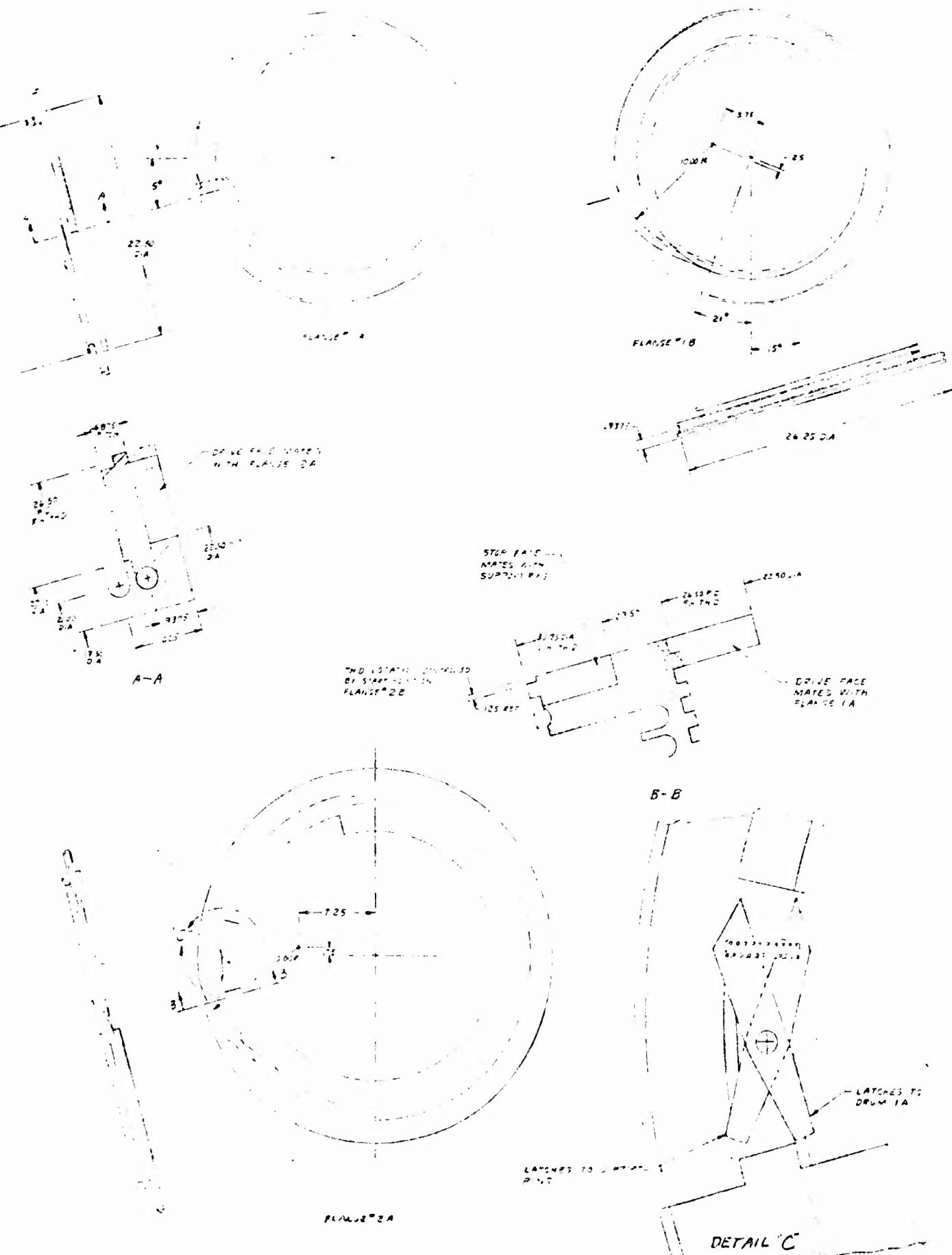
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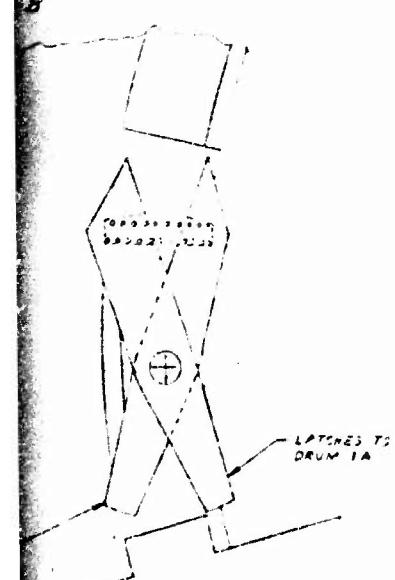
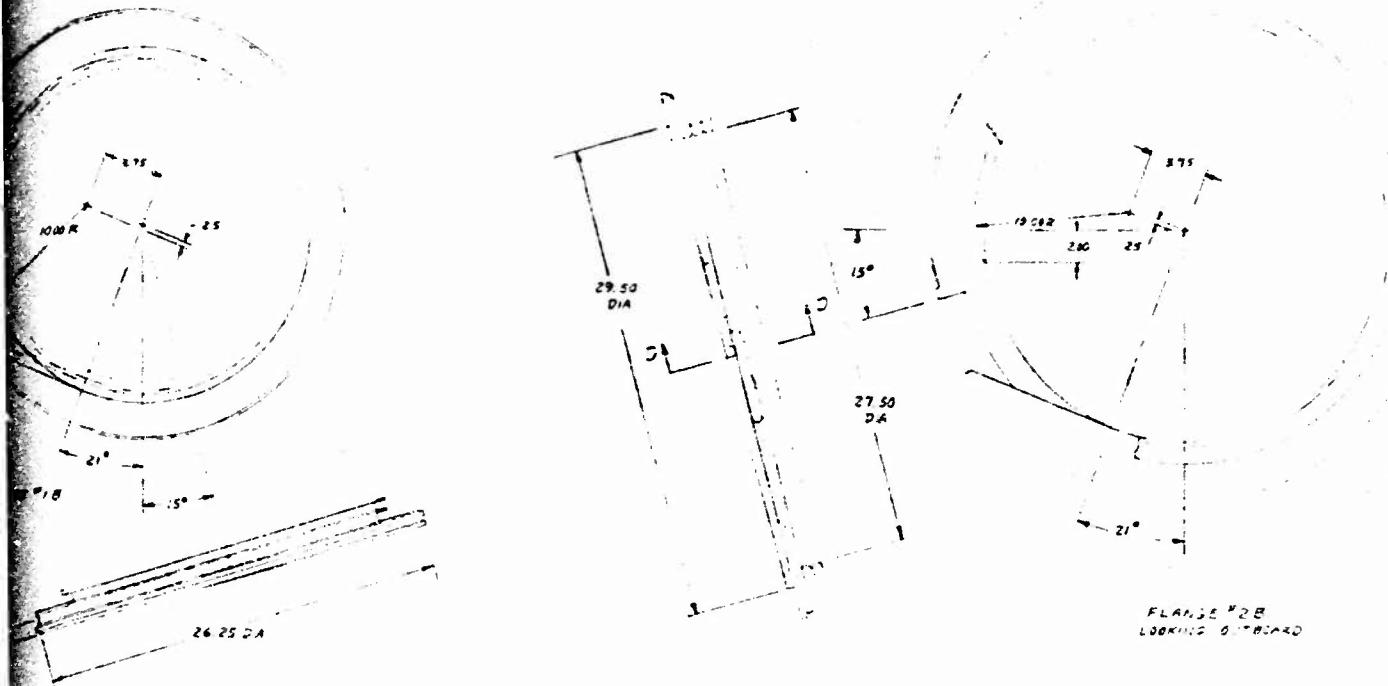
\* ROTARY DRIVE CYLINDER  
— TRANSVERSE SLIDE WAYS



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UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES BREAK ALL SHARP EDGES MAX BEND RADIUS TOLERANCE: FRACTION: ± ANGLES: ± DEG DEC: ± RAD DEC: ±		ITEM NO.	NAME	Hydrospace Research Corporation Rockville Maryland MULTIPLE DRUM WINCH SCAT	
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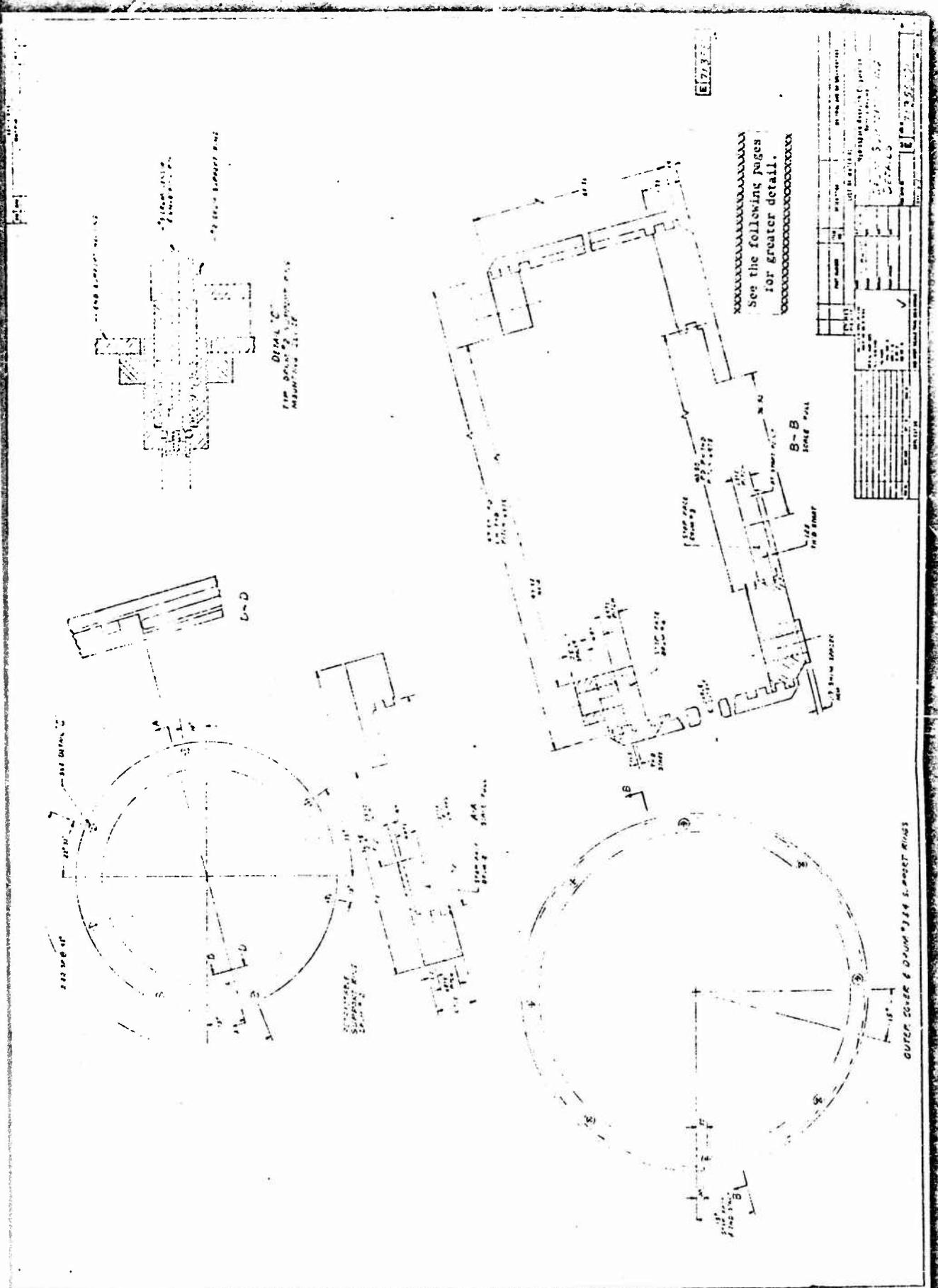
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CABLE PD	21.00	28.00	35.10
GD THD PD	26.50	33.50	42.50
CABLE ANGLE	21°	25°	29°
DRUM V. DTH			OVER SPOOL
41 TURNS	20.00		41.00
42 TURNS	24.75		

DRUM V. DTH  
41 TURNS = 20.00  
42 TURNS = 24.75

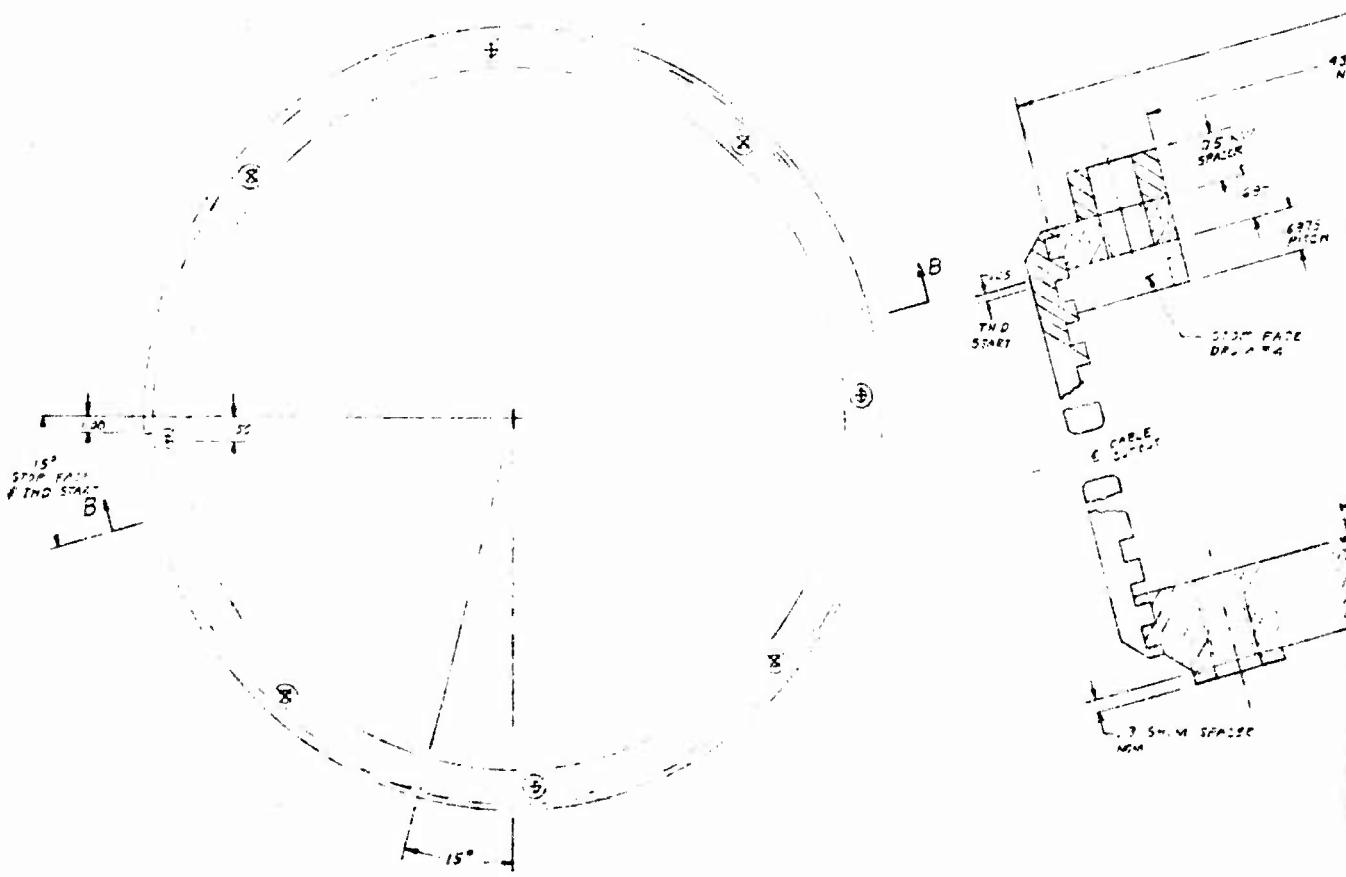
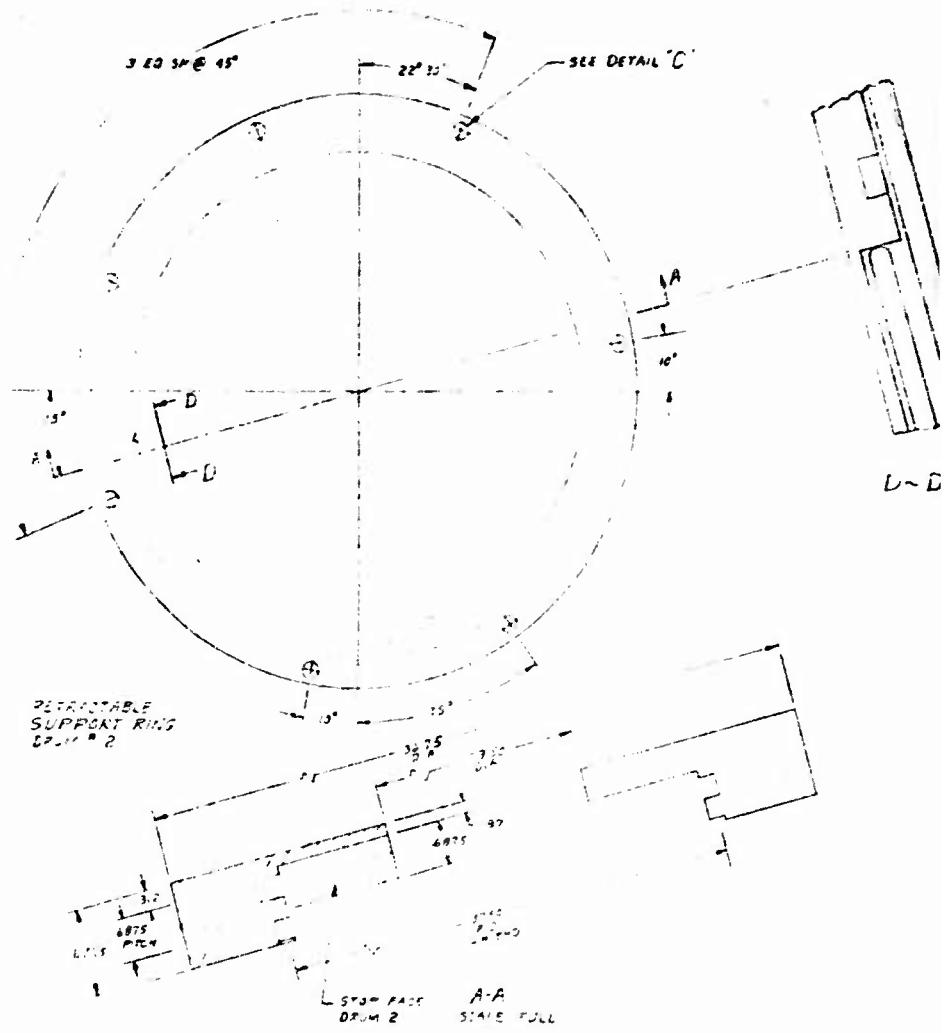
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E 7355001				

DETAIL 'C'



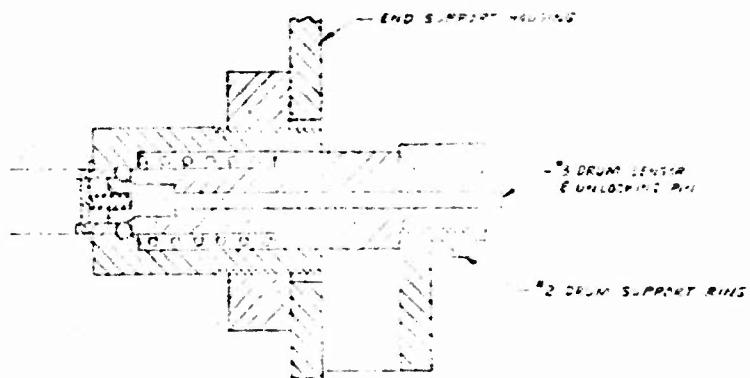
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DETAIL 'C'

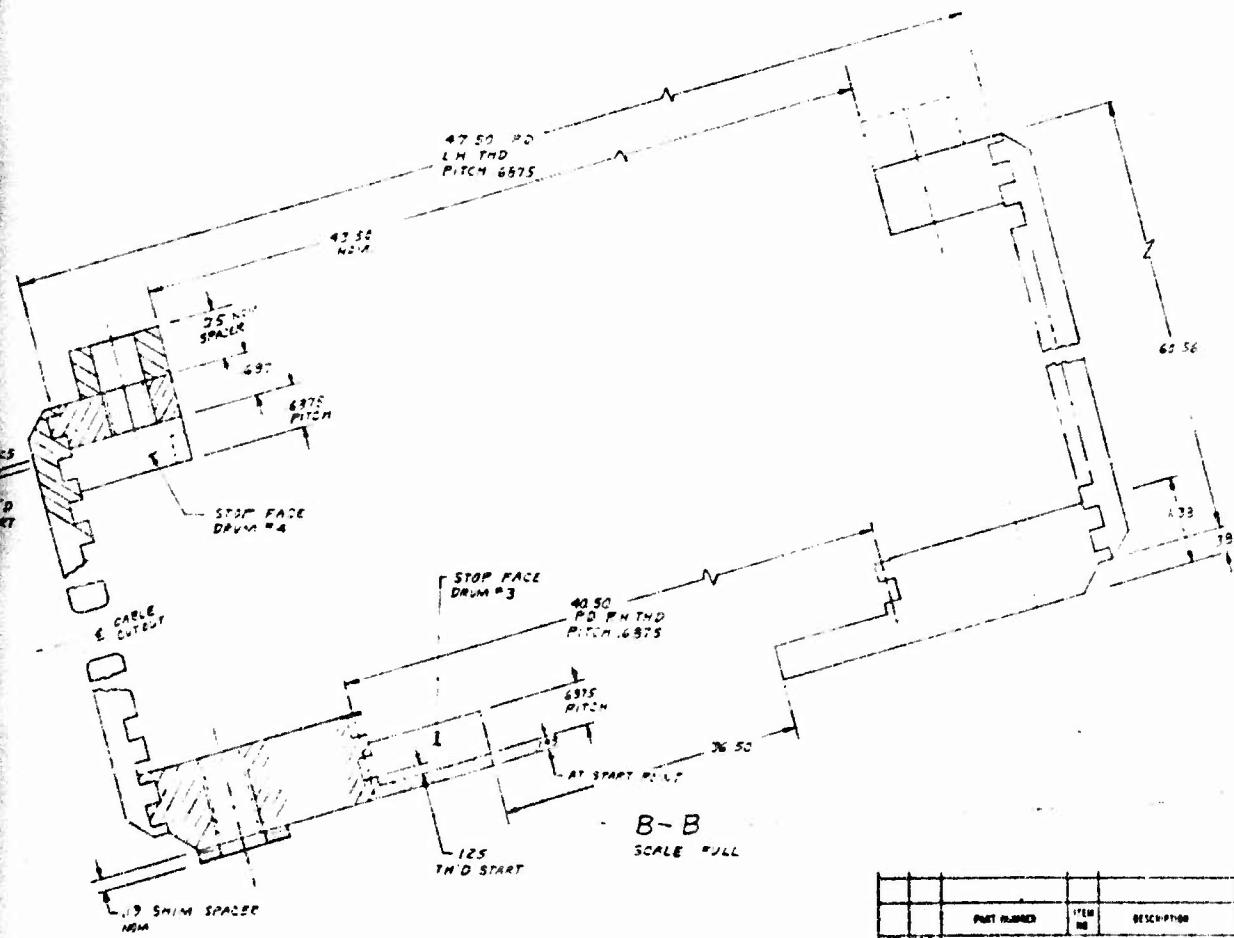
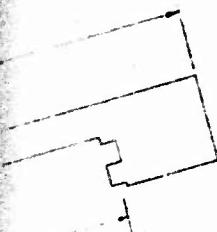


L-5



*DETAIL "C"*

TIP DRUM "Z" SUPPORT PLATE  
MOUNTING DEVICE



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REVIEW ARTICLE

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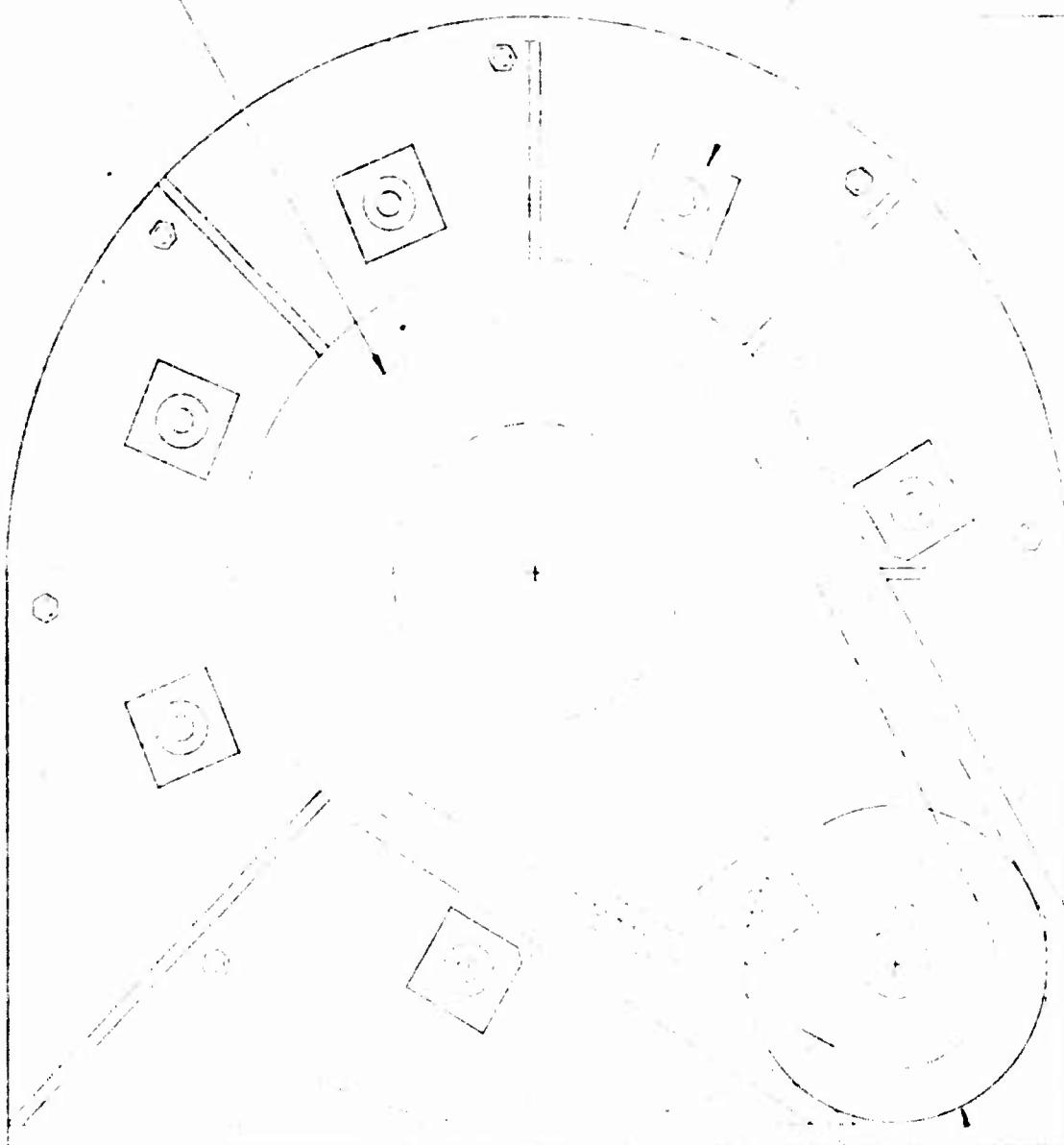
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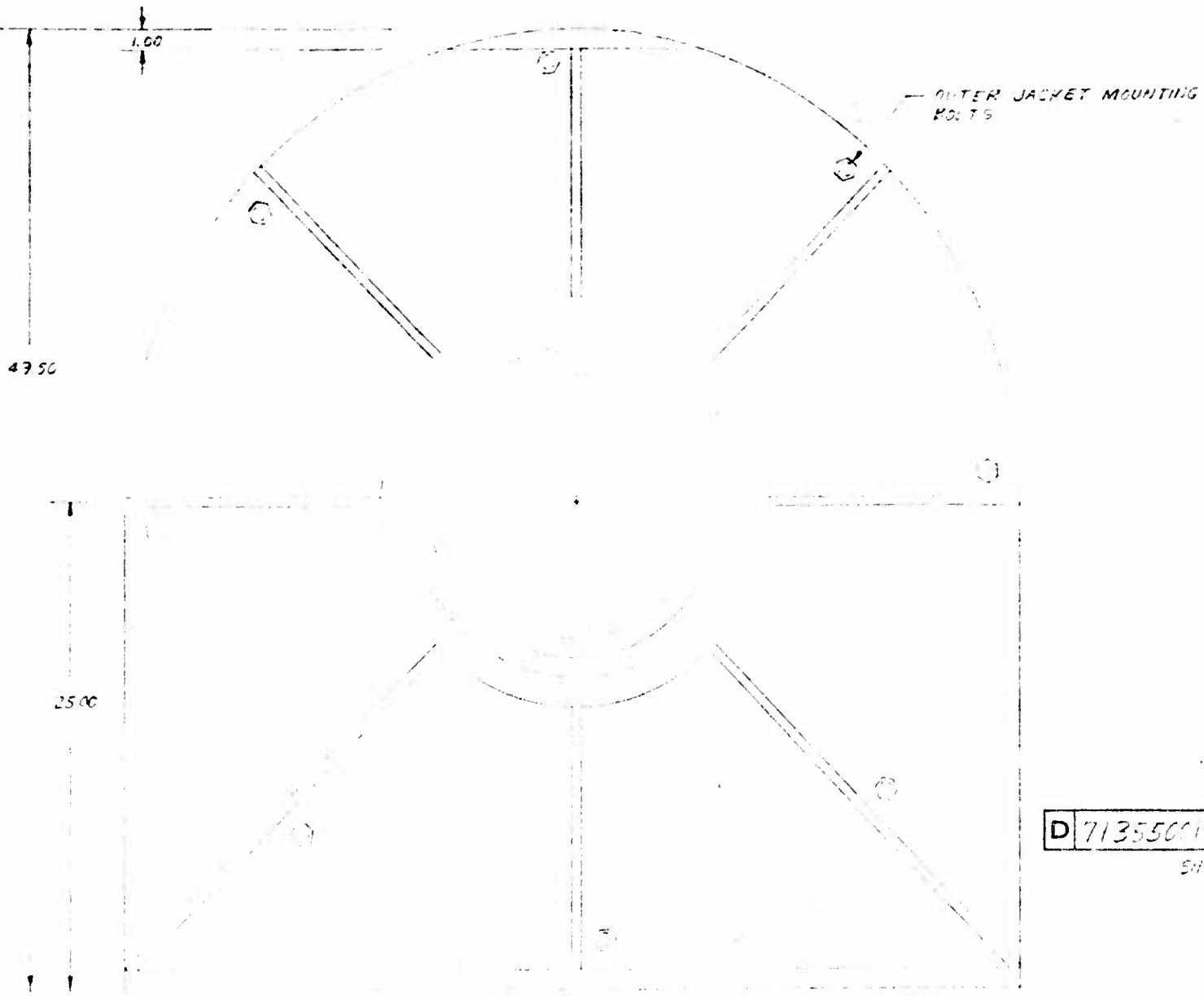
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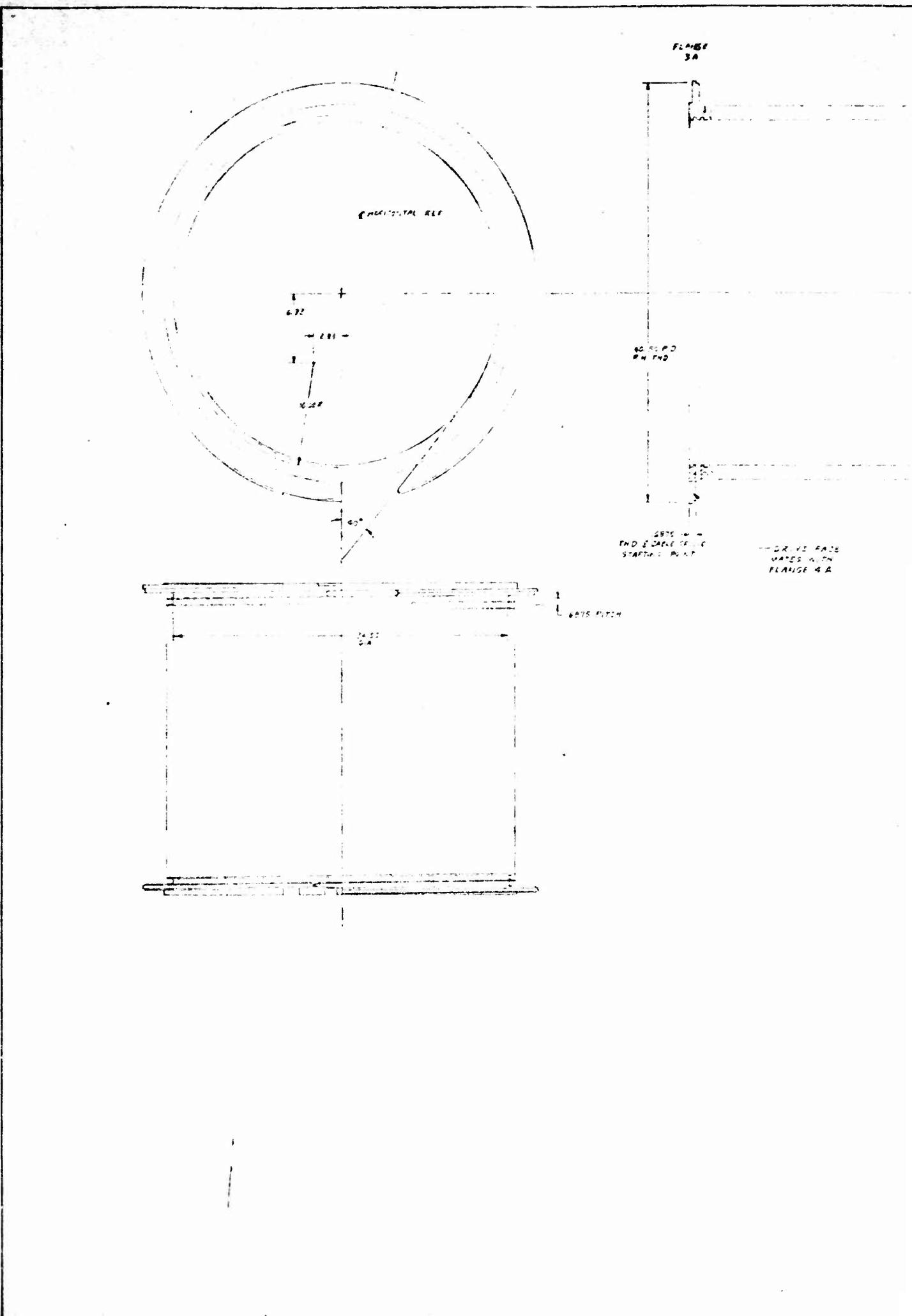


PLATE  
38

DRIVE FACE  
MATES WITH  
FLANGE 4A

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L47 FWD

1.6975 THD STARTS  
POINT

10.75R

10.16

7.50

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A'

DRIVE FACE  
MATES WITH  
FLANGE 2B

SUPPORT RING LATCH  
TRIMMED BY FLANGE 1P

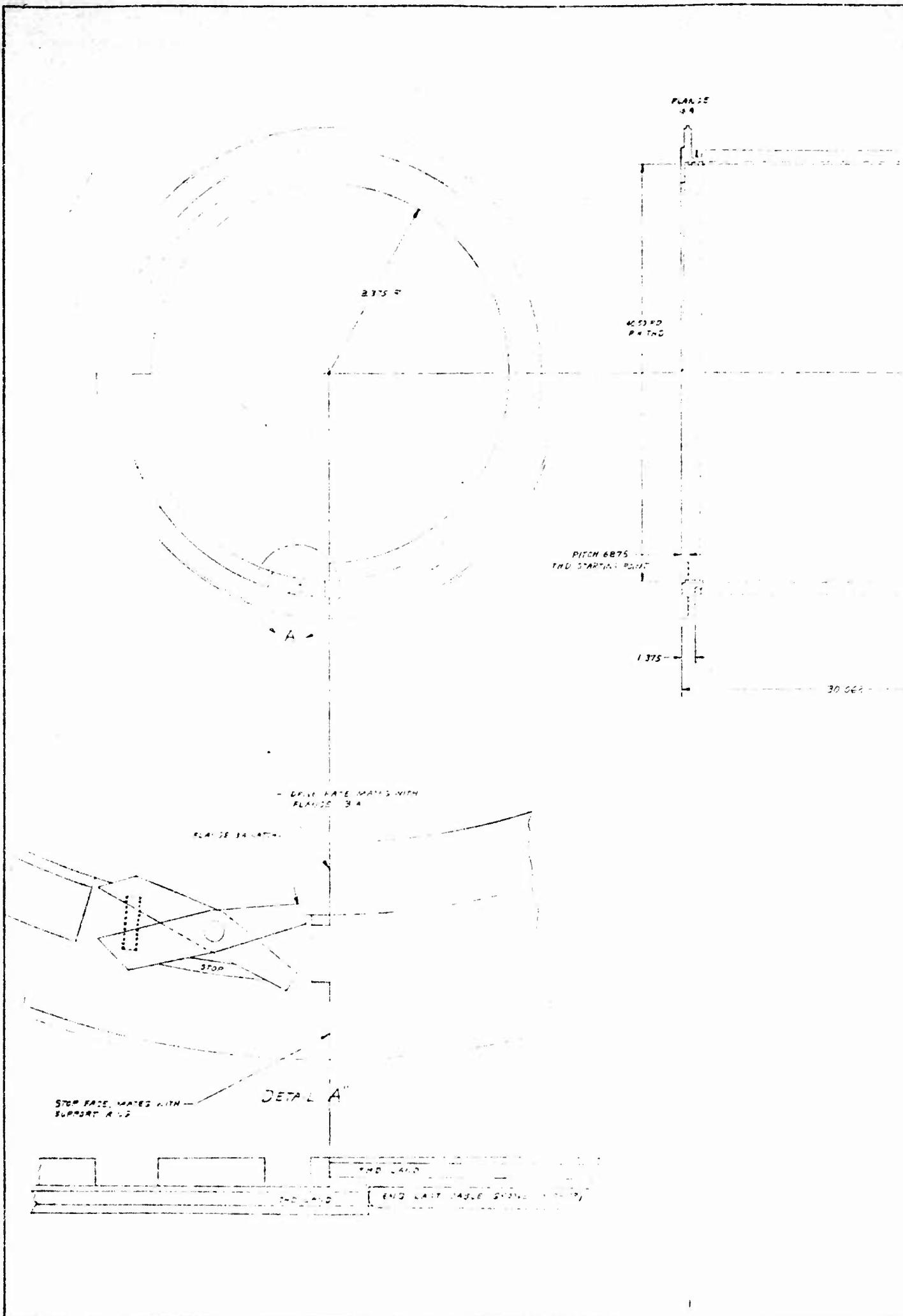
STOP FACE MATED WITH SUPPORT FACE

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APPENDIX B  
SCAT WINCH RESEARCH MODEL  
SPECIFICATION

B-1.

## SPECIFICATION

### WINCH, RESEARCH MODEL (RM) SUBMERSIBLE, CONCENTRIC, AXIALLY TRAVERSING (SCAT)

#### 1.0 SCOPE

This specification covers the performance requirements and sets the design constraints for the design, manufacture, and functional testing of a Submersible, Concentric, Axially Traversing (SCAT) Research Model Winch (RMW). This equipment shall be suitable for prototype testing associated with a feasibility demonstration of the SCAT concept and the ultimate design development of an operational SCAT winch system, suitable for handling a sectionally faired cable from a submerged platform.

#### 2.0 APPLICABLE DOCUMENTS

1. SCAT RM Winch Development Program -- Phase I Design Study  
October 22, 1971 -- Western Gear Corporation.
2. Federal QQ series material specifications.
3. American Gear Manufacturer's Association publications.

#### 3.0 REQUIREMENTS

##### 3.1 General

The intent of this specification is to define the requirements of a remotely operated submersible winch system for deploying, towing, and recovering a sectionally faired cable from a submerged platform. To satisfy a fundamental requirement of highly compact storage, the winch concept is based on the use of:

1. multiple drums,
2. concentrically nested on a common shaft, and
3. traversing axially along the shaft axis for level winding.

This concept is summarized by the acronym Submersible, Concentric, Axially Traversing (SCAT) winch. The SCAT concept and system characteristics are described in detail in the Phase I Design Study of the SCAT RM Winch Engineering Development Program (see Applicable Documents).

### **3.1.1 System Components**

The SCAT RM Winch shall include the following:

- a. A multiple drum winch to launch, tow, retrieve, and store sectionally faired cable.
- b. An electric winch drive including motor, gear reducer, brake, oil filled, pressure compensated enclosure, and remote motor controller.
- c. A tow cable continuity device or slip ring assembly.
- d. A sensor system for monitoring winch line speed, cable footage, and line tension. Line tension sensor is not restricted to installation in winch if analysis indicates that sensor may or must be located in ancillary winch system equipment, such as towing sheave, not covered by this specification.
- e. A control logic system for activating winch motor controller to automatically sequence winch speed at pre-determined points in deployment or recovery cycle. This logic system is not part of the RM winch specification but an awareness should exist, during winch design, of the ultimate need for system interlocks, and motor speed control based on footage, speed, and tension sensor input.

### **3.1.2 Size**

The maximum allowable dimensions for the SCAT RM Winch, including bedplate and all fixed appurtenances, shall be 47 inches in height and 56 inches in width. (parallel to drum axis). These dimensions are limited by installation compartment structure and must not be exceeded under any circumstances.

### **3.1.3 Weight**

The weight of the winch shall be a minimum consistent with the performance and design requirements set forth in the specification.

### **3.1.4 Environment**

The winch shall operate within the performance requirements of this specification during continual exposure to a submerged, fresh or seawater environment (in presence of marine contaminants such as silt, oil, sand, etc.) under the following specific conditions:

#### **3.1.4.1 Pressure**

The maximum environmental pressure shall be 1000 psi.

#### **3.1.4.2 Temperature**

The ambient temperature range shall be 28° F to 100° F. The winch shall also be capable of intermittent operation, at rated power, in air, when subjected to ambient air temperatures of -20° F to 120° F.

#### **3.1.4.3 Shock**

The winch is defined as Grade A equipment per MIL-S-901C. Although no shock qualification test will be imposed on the RM winch, the winch shall be designed according to shock design guidance principles per NAVSHIPS 250-423-31 and 250-660-30 with the intent of the design meeting MIL-S-901C shock requirements.

#### **3.1.4.4 Vibration**

The winch shall be capable of withstanding environmental vibration per MIL-STD-167. Although no environmental vibration test shall be performed on the RM winch, the design of the winch shall be consistent with the intent of meeting MIL-STD-167 vibration requirements.

#### **3.1.4.5 Inclination**

The operating inclination (roll and pitch) of the submerged platform is likely to be large. Design of the RM winch shall be consistent with the intent of making the winch structurally and operationally insensitive to orientation.

### 3.1.4.6 Material Selection

Selection of materials shall be based on the suitability for the environmental conditions and performance requirements specified herein. The Federal QQ series of material specifications shall govern selection of materials. All surfaces exposed to the environment shall be adequately protected against the corrosive action of seawater immersion.

Metals shall be selected or processed in a manner that insures corrosion resistance. Metals that are not inherently corrosion resistant shall be processed (painted, plated, coated, etc.) to provide corrosion resistance. Selection of dissimilar metals in areas of direct contact shall be made only after careful consideration relative to minimization of galvanic corrosion. Selection of fasteners and the design of areas of dissimilar metal contact shall be in accordance with intent of minimizing galvanic attack.

Special considerations shall be given to a separable grooved drum surface material or surface coating. Of fundamental importance in the design of the RM winch is the protection of the galvanized armor of the tow cable from electrolytic corrosion caused by contact with drum surface.

Selection and use of plastics shall be limited to those materials demonstrating dimensional stability and mechanical characteristics consistent with the performance requirements for the RM winch in a seawater submerged environment.

### 3.2.1 Material Fabrication

Welding shall be accomplished in accordance with Class M of MIL-STD-273.

### 3.3 SCAT RM Winch

The SCAT RM Winch shall be capable of deploying and recovering a sectionally furred, armored, electromechanical tow cable within the environmental and performance conditions specified herein. The winch mechanism

shall be self-contained and shall consist of a bedplate or frame, multiple concentric drums, drive mechanism including brake, controllity device or slip ring, appropriate sensors and a motor controller.

### 3.3.1 Bedplate

The bedplate shall be capable of supporting all subassemblies of the winch mechanism when subjected to the environment and loads specified herein and shall be capable of maintaining mechanical alignment of all subassemblies mounted thereon during shipment and when bolted to a foundation welded to the installation compartment decking.

### 3.3.2 Drums

The concentric multiple drums of the winch shall be capable of accommodating a minimum of 1000 feet of sectionally faired armored electromechanical tow cable in a single lay on three concentric nested drums. The cable system consists of a double armored (galvanized improved plow steel) electromechanical tow cable of 0.35 inches in diameter. The sectional fairing on the cable is 0.50 inches in diameter, with a 2.5 inch chord, and a section length of 2.0 inches. The minimum bend diameter of the assembled cable and fairing system is 24 inches.

#### 3.3.2.1 Drum Grooving

The surface of each of the three drums in the SCAT drum system shall be grooved to provide cable support and fairing alignment with a 9/16 inch pitch and 1/4 inch deep grooving. Special consideration shall be given to a separable grooved drum sleeve or drum surface coating of suitable material to inhibit electrolytic degradation of the galvanized tow cable armor.

#### 3.3.2.2 Drum Traverse Threads

Each drum shall be equipped with an internal thread which provides the traversing mechanism for the

sequential floating of the individual drums via engagement of threaded drum flanges with internal drum threads. The pitch of the internal threads shall be consistent with the pitch of the drum grooving to insure the proper advance of the drums relative to the cable. Special attention shall be given to means of minimizing the effect of seawater borne contaminants, fouling and corrosion on the operability of the threaded floating mechanism.

#### 3.3.2.3 Drum Flanges

The drum flanges shall be equipped with threaded flange inserts matching the internal drum threads. The use of UHMW polyethylene or equivalent is recommended for the flange inserts to provide a non-corroding, self-lubricating, abrasion resistant thread material suitable for continuous operation in a seawater environment.

#### 3.3.2.4 Drum Splines

The means of transmitting torque from the main drum drive shaft to the drum system shall be via suitable low friction spline connections capable of transmitting the required drive torque with minimum resistance to axial drum floating. The recirculating ball spline system discussed in the Phase I design study (see Applicable Documents) is recommended with special attention required for a design suitable for continuous reliable operation in a submerged seawater environment.

#### 3.3.2.5 Drum Latches

Suitable latching mechanisms shall be provided for the drums to effect automatic engagement and disengagement between the drums and side frames. The mechanical latch concept described in the Phase I design study (see Applicable Documents) is recommended, with detailed attention required

to a design suitable for continuous reliable operation in a submerged seawater environment. Special consideration shall be given to means of cushioning engagement impact shock and minimizing latch actuation noise.

### 3.3.2.6 Drum Ramps

Suitable ramps shall be provided on the drums to effect smooth cable transition from drum to drum. The ramps shall be configured to minimize the unsupported cable length between the drums and shall present no local bend discontinuities to the cable system. The ramp geometry derived from the Phase I engineering study shall be used for design guidance.

### 3.3.2.7 Drum Cable Termination

The innermost drum shall incorporate a tow cable attachment, which shall hold the tow cable to the drum when subject to a tension equal to the breaking strength of the cable (14,000#).

### 3.3.2.8 Main Drum Bearings

The multiple drum assembly shall be supported on the main drive shaft by two anti-friction bearing assemblies, permitting rotation of the drums about the main drive shaft. The bearings shall be suitable for continuous operation in a submerged seawater environment. The bearings shall be capable of withstanding the thrust corresponding to operation of the winch at large angles of inclination.

The use of water lubricated, UHMW polyethylene (or equivalent) bearing elements (journal or ball) is encouraged with the intent of providing a maintenance free submersible bearing design.

## 3.3.3 Drive System

An internal drive system in accordance with the preliminary

design concept described in the Phase I engineering study shall be provided. Source power shall be from a 440V, 3 $\delta$ , 60Hz, remote power source (furnished by others). The drive system shall be capable of deploying and recovering the entire length of the sectionally faired tow cable under a maximum line tension of 5600 pounds at a maximum line speed of 150 fpm. The drive system shall consist of a submersible electric motor and controller, gear reducer, brake, and oil filled pressure compensated enclosure. The total length of the drive system shall be a minimum consistent with the requirements, to facilitate installation, and to provide maximum remaining volume in main drum shaft tube for sensor system.

#### 3.3.3.1 Motor

The final selection of the required drive motor shall be made after preliminary test program determines winch operational characteristics and efficiency. For the purpose of definition of drive system arrangement and design of gear reducer it shall be assumed that the drive motor shall be a Franklin Electric Sea-Mersible motor, suitable for submergence to 2000 psi with the following characteristics: 40/20 HP, 3 $\delta$ , 460 volt, 1800/900 RPM, NEMA B design.

#### 3.3.3.2 Motor Controller

The final selection of the required motor controller shall be made after selection of drive motor and final determination of required winch control characteristics.

#### 3.3.3.3 Gear Reducer

A planetary gear reducer in accordance with the preliminary design characteristics evolved in the Phase I engineering study shall be provided. All gearing shall be in accordance with American Gear Manufacturer's Association (AGMA) publications. The reducer shall be suitable for operation in an oil flooded pressure compensated enclosure. The

reducer shall be compatible with the performance of the electric motor to provide an inhaul-outhaul capability for the winch of 5600 pounds at a maximum line speed of 150 fpm. The reducer shall be consistent also with the requirement to handle the maximum line load at reduced motor speed (1/2 or 1/3) and also a possible "creep" speed. The reducer shall be designed from a strength standpoint to withstand a maximum static load corresponding to the breaking strength of the cable (14,000 pounds). Special attention shall be paid to gear and enclosure design to minimize generated noise consistent with the covert nature of the SCAT winch application.

#### 3.3.3.4 Brake

The drive system shall be equipped with a brake capable of holding a static load corresponding to the breaking strength of the cable (14,000#) on the outer drum. The brake shall be spring set and electrically released and automatically sequenced for release with the winch motor controller. The brake shall be fail safe and provide stoppage of the drum system should there be a loss of power. The brake shall be suitable for operation within an oil filled pressure compensated drive enclosure. The multiple disc, spring loaded-electrically released brake preliminary design developed in the Phase I design study shall be used for guidance.

#### 3.3.3.5 Enclosure

The total drive system shall be enclosed by an oil filled pressure compensated housing suitable for installation within the main drum shaft tube. The drive system and housing shall be designed as a module to facilitate installation within the drum system and for ready removal for inspection and maintenance of drive system components.

### **3.3.4 Cable Continuity Device**

A cable continuity device or slip ring shall be provided suitable for maintaining electrical continuity for 7 tow cable conductors. The device shall be suitable for operation in a submerged seawater environment. Packaging of the slip ring relative to the drive system within the allowable winch envelope appears to be a problem of considerable magnitude. Continuity device concepts of minimum size (face type, ribbon cable type, etc.) should be given special consideration. Detailed continuity device electrical requirements will be furnished by others at later date.

### **3.3.5 Sensors**

The winch system shall be provided with a sensor system suitable for providing cable footage and cable speed instrumentation read-outs. Consideration shall be given during design to the interfacing of sensor inputs with motor control logic system to automatically sequence motor speed control at predetermined cable lengths.

## **4.0 QUALITY ASSURANCE PROVISIONS**

### **4.1 Responsibility for Inspection**

The contractor is responsible for the performance of all inspection requirements specified herein.

#### **4.1.1 Quality Control**

The contractor shall provide and maintain a quality control program in accordance with MIL-Q-9858.

### **4.2 Test Program**

The test programs for the SCAT RM Winch shall demonstrate and certify that all requirements of the specification have been satisfactorily incorporated into the equipment.

The SCAT RM Winch will be subjected to an intensive evaluation test program in a subsequent development program phase not covered by this specification.

The testing requirements covered by this specification shall be restricted to a landbased functional checkout of the operational characteristics of the winch mechanical elements and the adequacy of the drive system to meet the design load-speed-braking objectives. As a minimum the test procedures shall include:

No load

The winch shall be operated under no load for a period of 1/2 hour in each direction of rotation. The purpose of this test is to observe the functional operation of the mechanical elements of the winch system.

Rated load

The winch shall be operated hoisting and lowering rated load through rated speed range in each direction for 30 minutes. The test set-up shall allow this test to be performed on any drum of the multiple drum system and also through the drum-latch engagement points.

Brake

The winch shall have the electric brake subjected to a static pull equal to the static line tension rating for the brake.

APPENDIX C  
SCAT WINCH - DRAWINGS AND PARTS LISTS

CONTENTS

<u>Parts List</u>	<u>Drawing</u>	<u>Title</u>
PLE301207	E301207	SCAT Winch Assembly
PLE301215	E301215	Drum #1 Assembly
PLE301216	E301216	Drum #2 Assembly
PLE301217	E301217	Drum #3 Assembly
PLD303915	D303915	Right Side Plate Assembly
PLD303916	D303916	Left Side Plate Assembly
PLD303919	D303919	Main Shaft Assembly
PLD303929	D303929	Inner Shaft Assembly

C-1

# CONTROL SHEET

NOTE:

LTR	REVISIONS		REVISIONS		APPROVED	DATE	APPROVED
	DESCRIPTION	DATE	DESCRIPTION	DATE			
A	F/N-11, VOMINTAURE, WAS.	7/1/72					
K	DRIVE ASSY.						
K	COLLETED S/N 72	2/18/72					

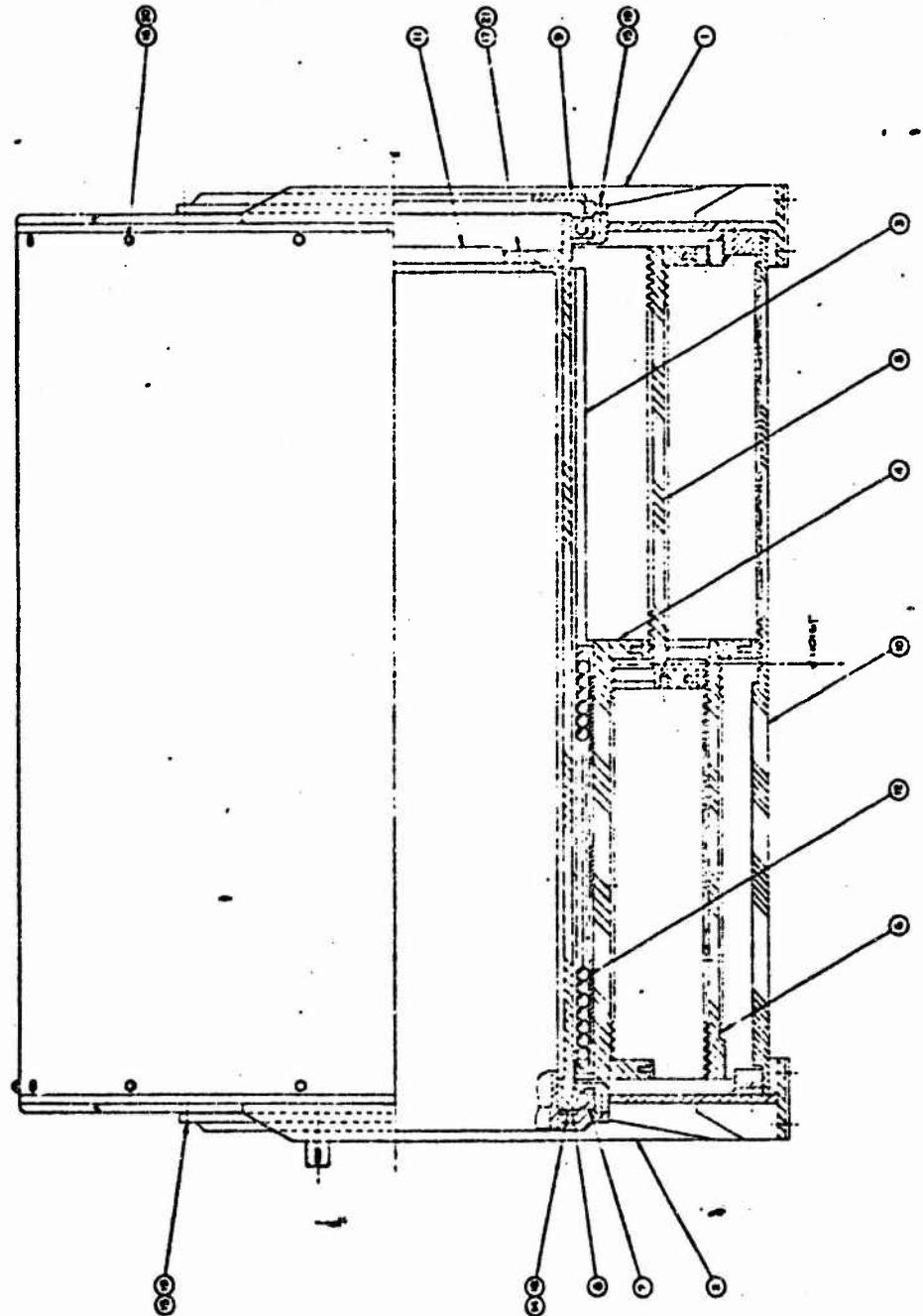
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REV	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100

C-1a



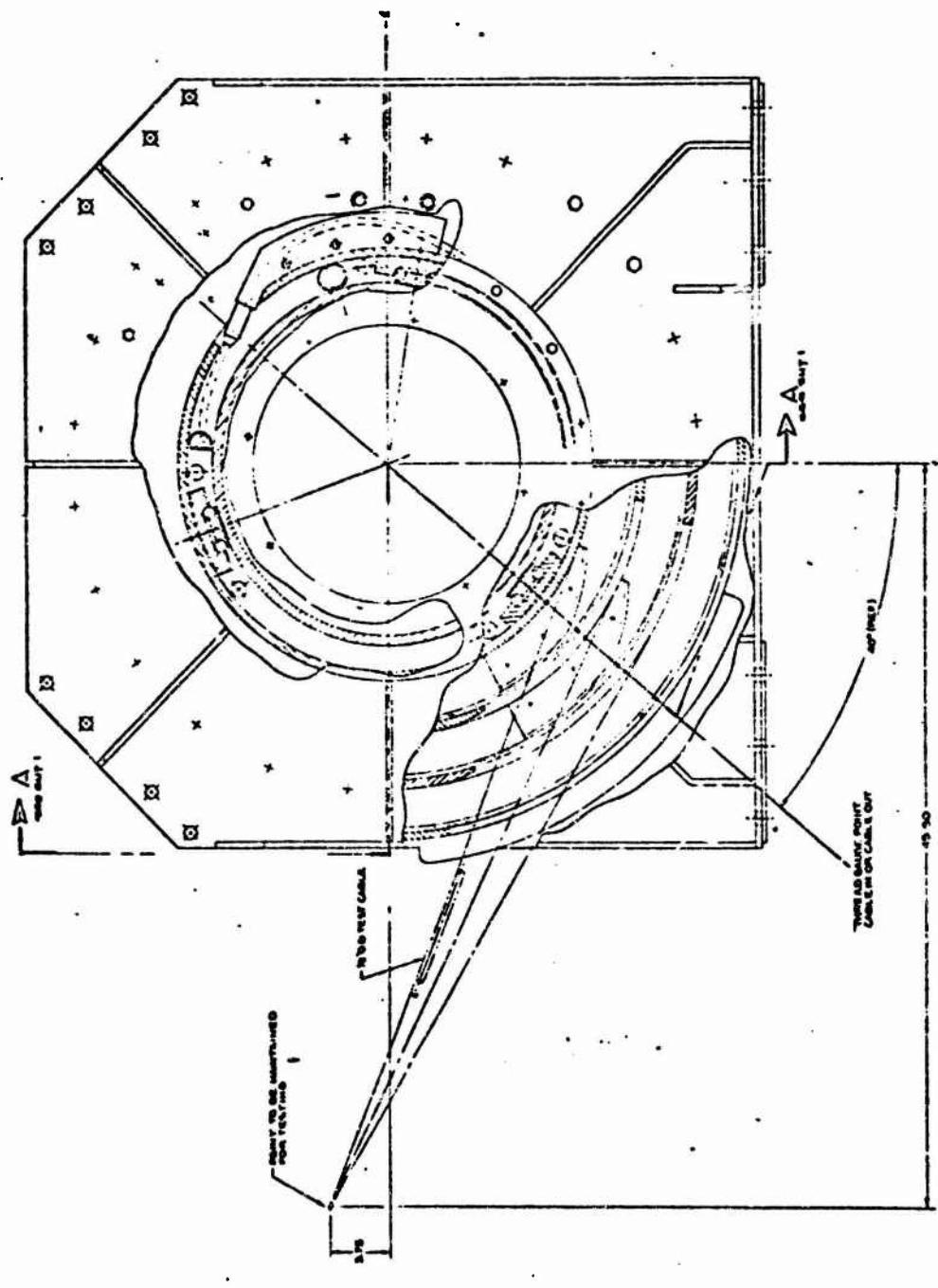
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the date of issuance and amount outstanding.  
The amount outstanding at the time of issuance  
is the principal amount of the note. The amount  
outstanding at the time of maturity is the principal  
amount plus any accrued interest. The amount  
outstanding at the time of payment is the principal  
amount minus any principal paid. The amount  
outstanding at the time of cancellation is the  
principal amount minus any principal paid and  
any accrued interest. The amount outstanding  
at the time of conversion is the principal amount  
plus any accrued interest. The amount outstanding  
at the time of conversion is the principal amount  
minus any principal paid and any accrued interest.  
The amount outstanding at the time of conversion  
is the principal amount plus any accrued interest.  
The amount outstanding at the time of conversion  
is the principal amount minus any principal paid  
and any accrued interest. The amount outstanding  
at the time of conversion is the principal amount  
plus any accrued interest.



Section A-A

SCAT WINCH  
ASSEMBLY  
E 10001 [E 301207] A



CONTROL SHEET

三

REVISIONS		DESCRIPTION	DATE	APPROVED	LTR	DESCRIPTION	DATE	APPROVED
A		EN - 2 THESE WERE 316L	6/72	HC				
B		UNLETED F/N 12	1/72					

REVIEWS

REVISIONS					
REV SONS	DESCRIPTION	DATE	APPROVED	LTR	DESCRIPTION
A	EN - 2 THRU 3161	6/12	KC	-	-

C-5

**CERTIFICATION LEGEND**

- C CHEMICAL  
P PHYSICAL  
H HARMONIES  
CC CERTIFI-  
ED MUNICES  
PT LUM  
MT MA  
HT RA  
P PH  
UT U

EVERETT. WASHINGTON

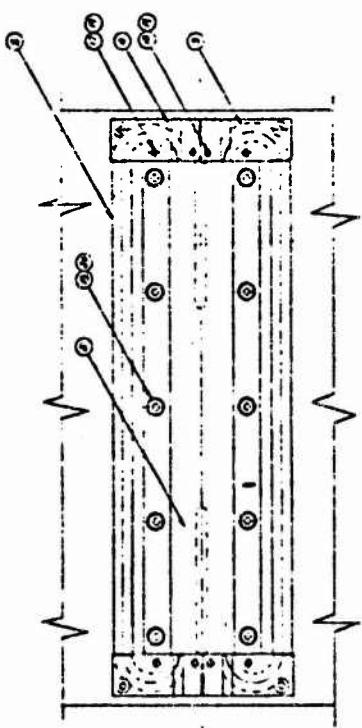
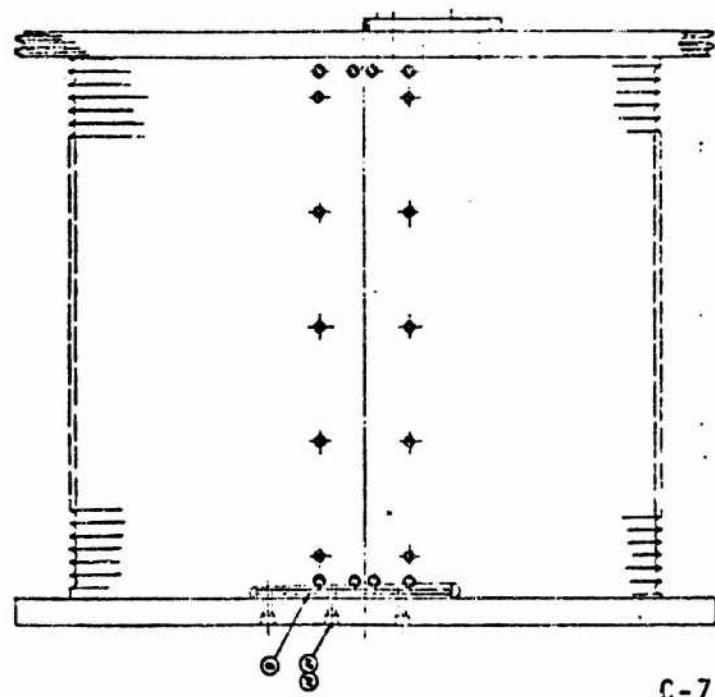
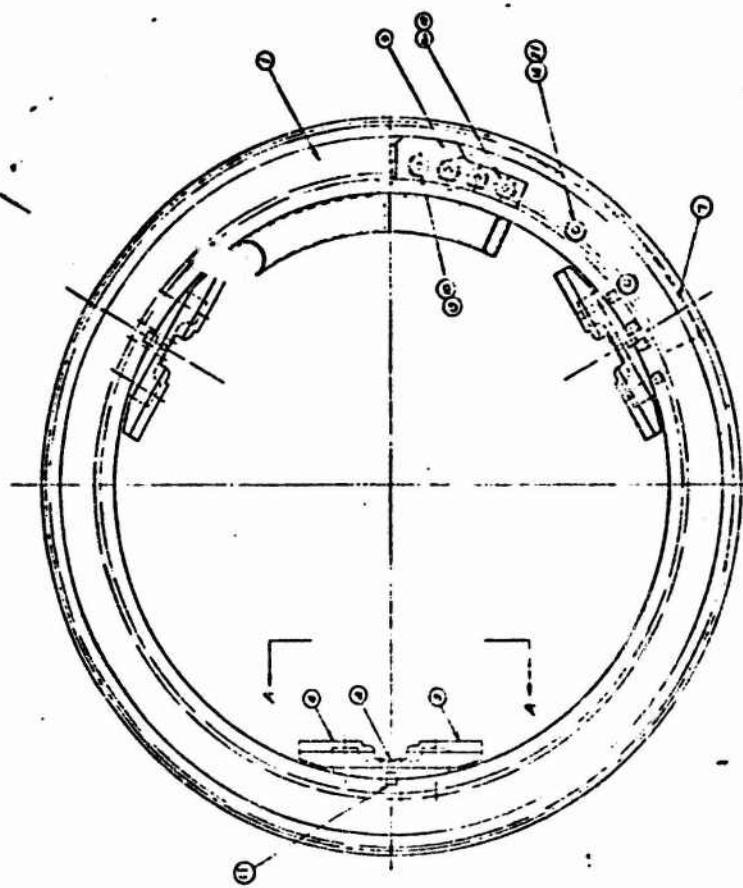
ARTS LIST

DRUM CLASSES  
SCAT VINCH

PLE 301215  
16603 B

SCALE - WT. 6.50 lb SELL 1 or 2

ITEM	DESCRIPTION	QTY.	CODE	PART OR DOC NO.	MANUFACTURER NAME	MATERIAL SPEC.	REQUOTERS	ALTERNATE SPEC FOR COPY REFERENCE	WT LBS	REMARKS			
										C	P	H	G
1	DRAIN NC . 1	1	E301208	WGC	VAR	SEE DWG.	SST	QQ-S-766 CL TYPE 316					
2	OUTER TRACK	3	C306609	WGC		QQ-S-766 CL	SST	QQ-S-766 CL TYPE 316					
3	BALL RETURN LH	6	0303921	WGC		QQ-S-766 CL	SST	QQ-S-766 CL TYPE 316					
4	BALL RETURN RH	6	0303917	WGC		QQ-S-766 CL	SST	QQ-S-766 CL TYPE 316					
5	TUBE BALL RETURN	6	C306627	WGC		QQ-S-766 CL	SST	QQ-S-766 CL TYPE 316					
6	FIX BLOCK	1	C306617	WGC		VAR	SEE DWG.	QQ-S-741 CL					
7	DEAD END CABLE RAMP	1	C304610	WGC		QQ-S-741 CL	SSTL	A36HR					
8													
9	CABLE RAMP	1	C304615	WGC		QQ-S-741 CL	SSTL	A36 HR					
10	BUSHING	4	B303901	WGC		QQ-S-741 CL	SSTL	A36HR					
11	KEY	6	88614	WGC		TYPE 303	SST						
12													
13	FLAT SOC HD CAPSCREW	3		COMML			SST	COMML					
14	SOC HD CAPSCREW	5		COMML			SST	COMML					
15	SOC HD CAPSCREW	30		COMML			SST	COMML					
16	FLAT SOC HD CAPSCREW	1		COMML			SST	COMML					
17	SOC HD CAPSCREW	12		COMML			SST	COMML					
18	SOC HD CAPSCREW	12		COMML			SST	COMML					
19	LOCKWASHER	24		COMML			SST	COMML					
20	LOCKWASHER	30		COMML			SST	COMML					
21	LOCKWASHER	5		COMML			SST	COMML					
<b>C-6</b>													
SIZE													
B										16	16	16	16
C										16	16	16	16
D										16	16	16	16
E										16	16	16	16
F										16	16	16	16
G										16	16	16	16
H										16	16	16	16
I										16	16	16	16
J										16	16	16	16
K										16	16	16	16
L										16	16	16	16
M										16	16	16	16
N										16	16	16	16
O										16	16	16	16
P										16	16	16	16
Q										16	16	16	16
R										16	16	16	16
S										16	16	16	16
T										16	16	16	16
U										16	16	16	16
V										16	16	16	16
W										16	16	16	16
X										16	16	16	16
Y										16	16	16	16
Z										16	16	16	16
AA										16	16	16	16
BB										16	16	16	16
CC										16	16	16	16
DD										16	16	16	16
EE										16	16	16	16
FF										16	16	16	16
GG										16	16	16	16
HH										16	16	16	16
II										16	16	16	16
JJ										16	16	16	16
KK										16	16	16	16
LL										16	16	16	16
MM										16	16	16	16
NN										16	16	16	16
OO										16	16	16	16
PP										16	16	16	16
QQ										16	16	16	16
RR										16	16	16	16
SS										16	16	16	16
TT										16	16	16	16
UU										16	16	16	16
VV										16	16	16	16
WW										16	16	16	16
XX										16	16	16	16
YY										16	16	16	16
ZZ										16	16	16	16
AA										16	16	16	16
BB										16	16	16	16
CC										16	16	16	16
DD										16	16	16	16
EE										16	16	16	16
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GG										16	16	16	16
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II										16	16	16	16
JJ										16	16	16	16
KK										16	16	16	16
LL										16	16	16	16
MM										16	16	16	16
NN										16	16	16	16
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PP										16	16	16	16
QQ										16	16	16	16
RR										16	16	16	16
SS										16	16	16	16



C-7

# CONTROL SHEET

NO. 5

REVISIONS	DESCRIPTION			DATE APPROVED	LTA	DESCRIPTION	DATE APPROVED	LTA
	DATE	APPROVED	LTA					
A	EN-5, WAS 316L	6/12	W					

HEAVY MACHINERY DIVISION EVERETT, WASHINGTON  PARTS LIST  WESTERN INDUSTRIAL CORPORATION	DRUM SCAT WINCH											
	SER	1	2									
	H/LV	A	A									
	SPR											
	REV											

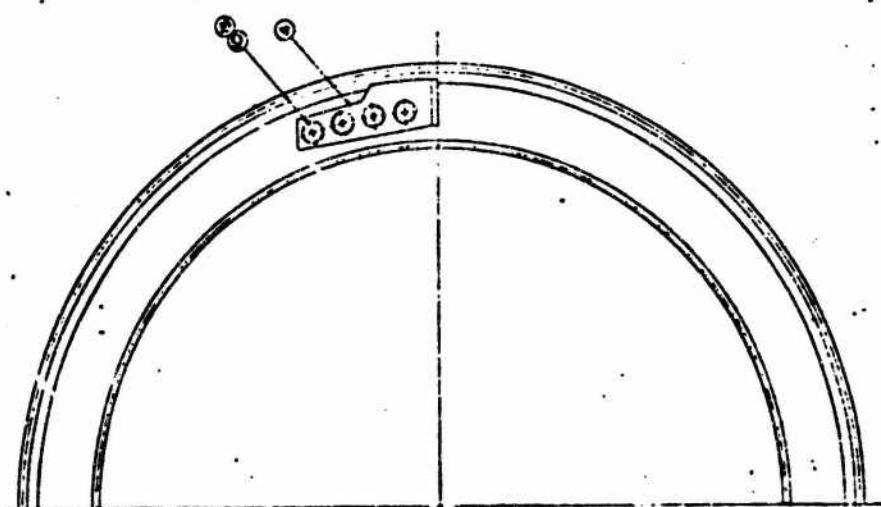
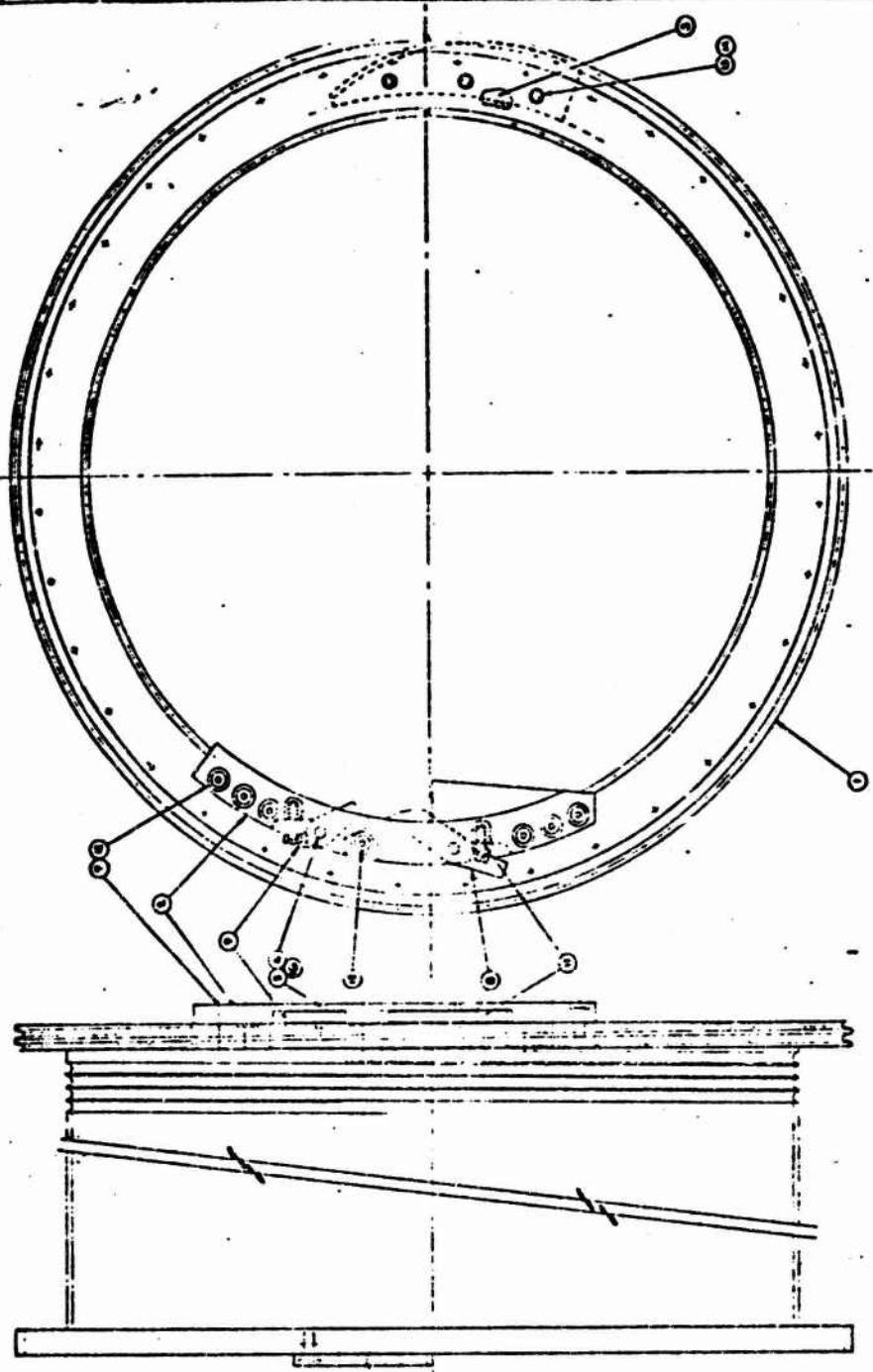
## CERTIFICATION LEGEND

C CHEMICAL	P PHYSICAL
H HARDNESS	H HARDNESS
C/C CERTIFICATION OF CONFORMANCE	C/C CERTIFICATION OF CONFORMANCE
N/D NONDESTRUCTIVE TEST CONSISTING OF:	N/D NONDESTRUCTIVE TEST CONSISTING OF:
PT LIQUID PENETRANT INSPECTION	PT LIQUID PENETRANT INSPECTION
M/M MAGNETIC PARTICLE INSPECTION	M/M MAGNETIC PARTICLE INSPECTION
RF RADIOGRAPHIC INSPECTION	RF RADIOGRAPHIC INSPECTION
UT ULTRASONIC INSPECTION	UT ULTRASONIC INSPECTION

A

SC. 103	PL 30126	B	16603	CODE IN MD.	16	16	-	16
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	ITEM	REF.	QTY.	CODX. IN EN.	PART NO. DNC NO.	MANUFACTURER NAME	MATERIAL	WEIGHT PER PCS	ALTERNATIVES ALTERNATIVES ALTERNATIVES ALTERNATIVES	ALTERNATIVES ALTERNATIVES ALTERNATIVES ALTERNATIVES	ALTERNATIVES ALTERNATIVES ALTERNATIVES ALTERNATIVES
1	DURUM NO. 2		1		E301209	WGC	STEEL	0.005			
2	HOUSING		1		E301214	WGC	STEEL	0.005-0.03			
3	CABLE ARM		1		C304616	WGC	STEEL	0.005-0.74			
4	FIX BLOCK		1		C304620	WGC	VAR SEE DWG				
5	SHAFT		2		B301839	WGC	SST	QQ-S-766			
6	FLUSHING		2		B303900	WGC	UHMW POLYTHN COMYL				
7	BUSHING		10		B303901	WGC	STL	QQ-S-633			
8	LATCH		1		C304619	WGC	STL	QQ-S-766			
9	LATCH		1		C304618	WGC	STL	QQ-S-766			
10	BUSHING		4		B304504	WGC	STL	QQ-S-633			
11	SPRING		2		LG-0425-12	LEE	SST	COMML			
12	FLAT SOC. HEAD CAPSCREW		2			COMML	STL	COMML			
13	SOC HD. CAPSCREW		3			COMML	STL	COMML			
14	LOCKWASHER		3			COMML	STL	COMML			
15	FLAT SOC HEAD CAPSCREW		4			COMML	STL	COMML			
16	SPACER		4		B303902	WGC	STL	COMML			
REMARKS											
300 SERIES											
CL. 1018-1020 HR											
CL. 1018-1020 HR											
3/8-16 NC X 1-1/8 LG											
3/8 HI-CAP											
CL. 1018-1020 HR											
1-7/16-14 NC X 1-5/8 LG											
OR EQUIVALENT											
CL. 1018-1020 HR											
3/8-16 NC X 1-1/8 LG											
CL. 1018-1020 HR											
C1-A-36											
C1-A-36											



# CONTROL SHEET

MU13

REVISIONS	DESCRIPTION			LTM	APPROVED	DATE	APPROVED
	LTR	REV	DESCRIPTION				
A	FN-3,445 WEDE 316 L		6-72	14-			

HEAVY MACHINERY DIVISION EVERETT, WASHINGTON		PARTS LIST	
<b>WESTERN</b> <small>GEAR CORPORATION</small>		DRUM #3 ASSY CAT WINCH	
DRAWN	LH	5/12/72	
CHECK	LH	5/12/72	
ENGR	F. Mayr	5/12/72	
SIZE	B	CODE IDENT NO.	REV.
	16603	PL E 301217	A
SCALE		WT.	LB
		SHEET	OF
		1	2

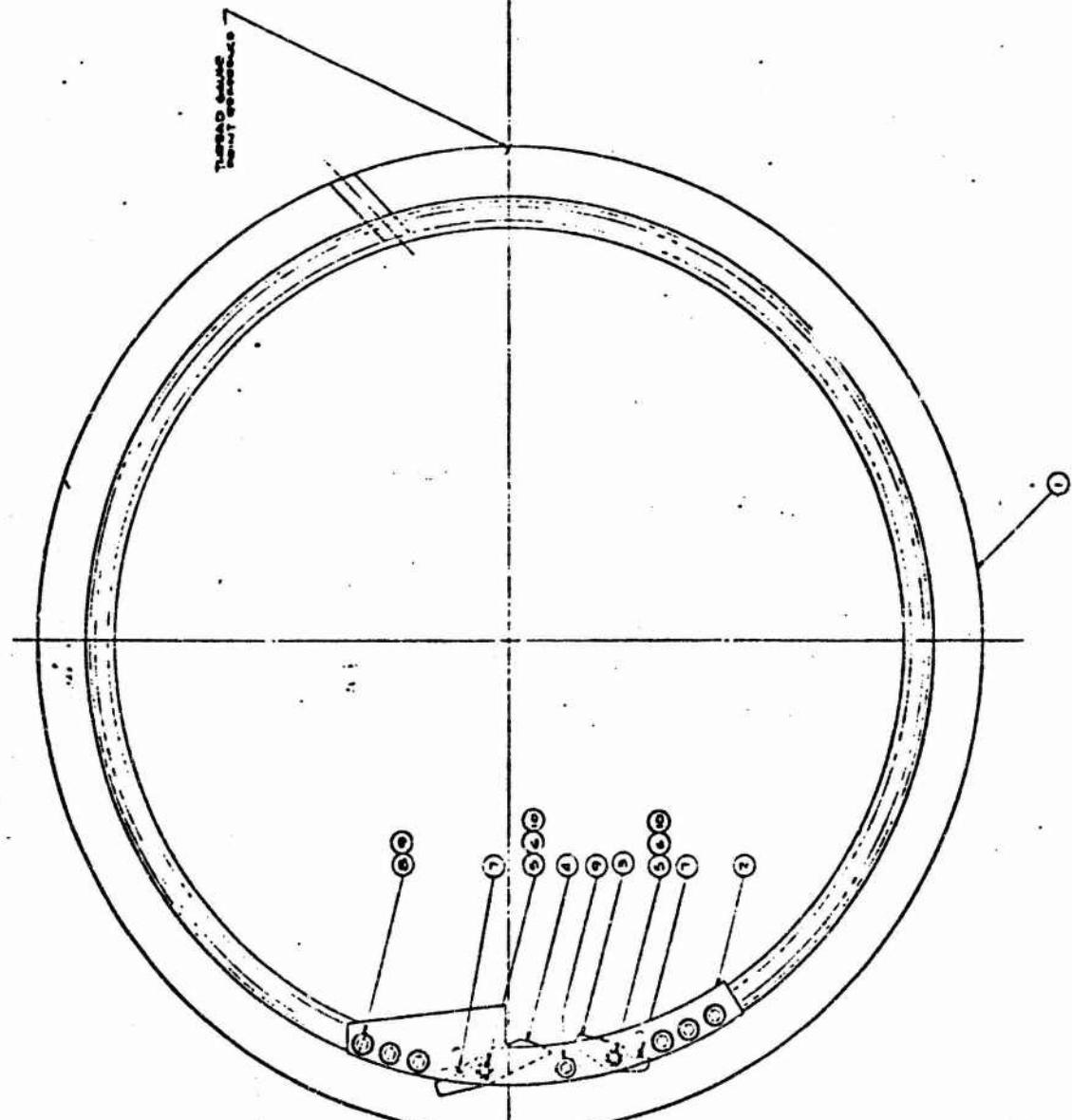
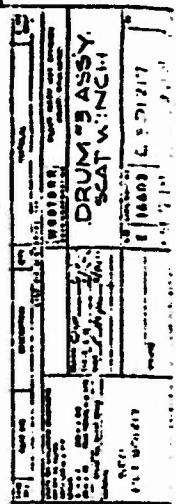
**CERTIFICATION LEGEND**

- C CHEMICAL
- P PHYSICAL
- M MANUFACTURE
- CC CERTIFICATION OF CONFORMANCE
- N/D NONDESTRUCTIVE TEST CONSISTING OF:
- PT LIQUID PENETRANT INSPECTION
- MT MAGNETIC PARTICLE INSPECTION
- RT RADIGRAPHIC INSPECTION
- P PRESSURE TEST
- UT ULTRASONIC TEST

ITEM	QUANTITY	CODE IDENT.	MANUFACTURER	PART OR Dwg NO.	NAME	MATERIAL	MATERIAL SPEC	PROD. CCLS				ALTERNATE SPEC FOR GOVT DIFFERENCE	WT LBS	REMARKS
								C	P	H	C	T	N	
1. DRUM #3	1	E301210	MGC	VAR.	QQ-S-741 CL									
2. HOUSING LATCHES	1	E301213	MGC	ST. STL	A36 HR									
2. DRUM #3	1				QQ-S-766									
3. LATCH REVERSE	1	C304621	MGC	ST. STL	CL316									
4. LATCH FORWARD	1	C304622	MGC	ST. STL	CL316	QQ-S-766								
5. SHAFT - LATCH	2	B303899	MGC	ST. STL	CL316	QQ-S-766								
6. BUSHING - LATCH	2	B303900	MGC	LFE	UHMW POLYTH.									
7. SPRING	2	LC-042E-17	ST. STL	QQ-S-741 CL										
8. BUSHING SHEAR	6	B303901	MGC	COML	COML									
9. SCR FLT HD SOCK	7													
10. SHIM	4	B303902	MGC	ST. STL										

7/16-14 NC X 1.62 LONG

REV A  
SIZE B CODE DRAFT NO. 16603 PLE301217  
STAIN - ST - TA SWETT 2



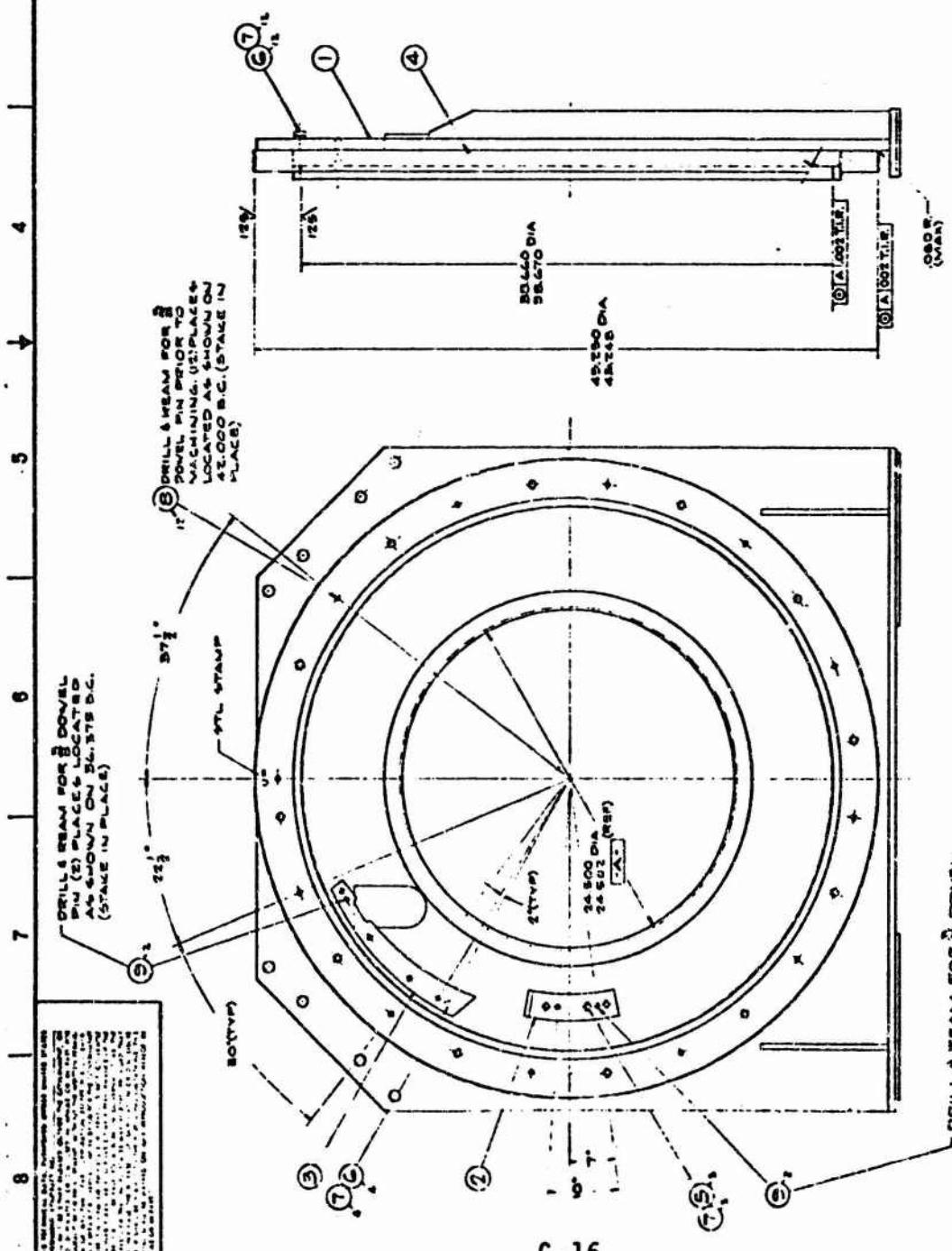


ITEM NO.	NOMENCLATURE	QTY.	CODE IDENT.	PART OR DRG NO.	MANUFACTURER	MATERIAL	MATERIAL SPEC	RECD CERTS				ALTERNATE SPEC FOR GOVT REFERENCE	WT LBS	REMARKS	CLASS	CLASS
								C	P	H	C	N	D			
1	SIDE PLATE	1		E301212	WGC	STL	00-S-741 G0-A-36 h.r. G0-S-36 h.r. CL-A-36 h.r.									
2	STOP BLOCK	1		C304611	WGC	STL	G0-A-36 h.r. G0-S-36 h.r. CL-A-36 h.r.									
3	FIX CAM BLOCK	1		D303918	WGC	STL										
4	RJNG	1		D303920	WGC	VAR	SEE DWG.									
5	HEX HD CAPSCREW	2				COMML	S-STL									
6	HEX HD CAPSCREW	16				COMML	S-STL									
7	LOCK WASHER	19				COMML	S-STL									
8	DOWEL PIN	16				COMML	S-STL									
9	DOWEL PIN	4				COMML	S-STL									

C-15

SIZE CODE IDENT NO. REV  
**B 16603**

SCALE 1" = 16 INCHES 2 OF 2



CONTROL SHEET

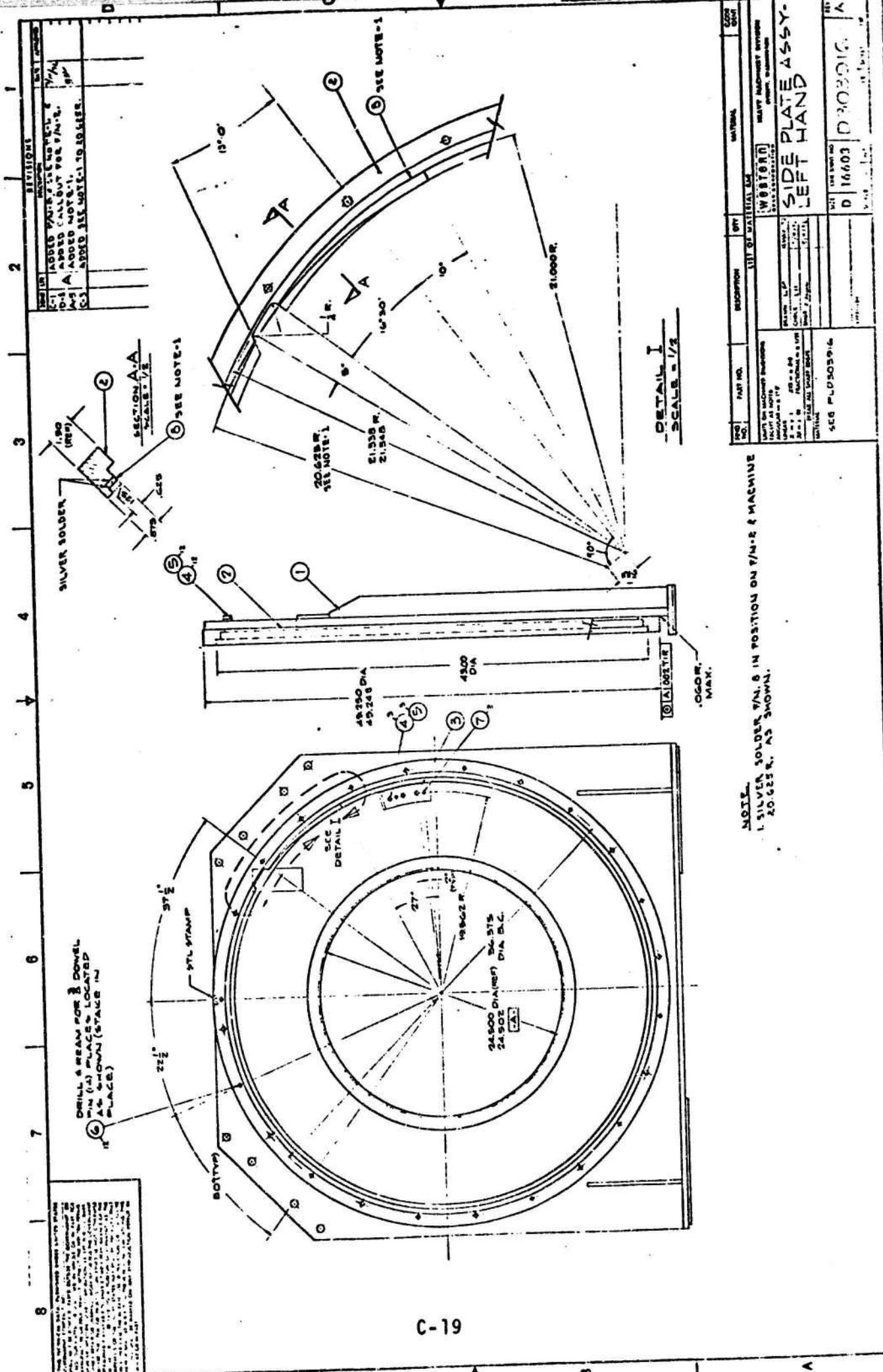
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CERTIFICATION LIST		PARTS LIST		DRAWING NO.	
S/N	REV	ITEM	DESCRIPTION	QTY	REV
SAT		1	SCAT	1	A
REV		2	WHEEL	1	
SAT	1	3	SWIVEL	1	
REV	A	4	SWIVEL	1	
SAT	2	5	SWIVEL	1	
REV	A	6	SWIVEL	1	
SAT	3	7	SWIVEL	1	
REV	A	8	SWIVEL	1	
SAT	4	9	SWIVEL	1	
REV	A	10	SWIVEL	1	
SAT	5	11	SWIVEL	1	
REV	A	12	SWIVEL	1	
SAT	6	13	SWIVEL	1	
REV	A	14	SWIVEL	1	
SAT	7	15	SWIVEL	1	
REV	A	16	SWIVEL	1	
SAT	8	17	SWIVEL	1	
REV	A	18	SWIVEL	1	
SAT	9	19	SWIVEL	1	
REV	A	20	SWIVEL	1	
SAT	10	21	SWIVEL	1	
REV	A	22	SWIVEL	1	
SAT	11	23	SWIVEL	1	
REV	A	24	SWIVEL	1	
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SAT	14	29	SWIVEL	1	
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REV	A	36	SWIVEL	1	
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REV	A	40	SWIVEL	1	
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REV	A	44	SWIVEL	1	
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REV	A	150	SWIVEL	1	
SAT	75	151	SWIVEL	1	
REV	A	152	SWIVEL	1	
SAT	76	153	SWIVEL	1	
REV	A	154	SWIVEL	1	
SAT	77	155	SWIVEL	1	
REV	A	156	SWIVEL	1	
SAT	78	157	SWIVEL	1	
REV	A	158	SWIVEL	1	
SAT	79	159	SWIVEL	1	
REV	A	160	SWIVEL	1	
SAT	80	161	SWIVEL	1	
REV	A	162	SWIVEL	1	
SAT	81	163	SWIVEL	1	
REV	A	164	SWIVEL	1	
SAT	82	165	SWIVEL	1	
REV	A	166	SWIVEL	1	
SAT	83	167	SWIVEL	1	
REV	A	168	SWIVEL	1	
SAT	84	169	SWIVEL	1	
REV	A	170	SWIVEL	1	
SAT	85	171	SWIVEL	1	
REV	A	172	SWIVEL	1	
SAT	86	173	SWIVEL	1	
REV	A	174	SWIVEL	1	
SAT	87	175	SWIVEL	1	
REV	A	176	SWIVEL	1	
SAT	88	177	SWIVEL	1	
REV	A	178	SWIVEL	1	
SAT	89	179	SWIVEL	1	
REV	A	180	SWIVEL	1	
SAT	90	181	SWIVEL	1	
REV	A	182	SWIVEL	1	
SAT	91	183	SWIVEL	1	
REV	A	184	SWIVEL	1	
SAT	92	185	SWIVEL	1	
REV	A	186	SWIVEL	1	
SAT	93	187	SWIVEL	1	
REV	A	188	SWIVEL	1	
SAT	94	189	SWIVEL	1	
REV	A	190	SWIVEL	1	
SAT	95	191	SWIVEL	1	
REV	A	192	SWIVEL	1	
SAT	96	193	SWIVEL	1	
REV	A	194	SWIVEL	1	
SAT	97	195	SWIVEL	1	
REV	A	196	SWIVEL	1	
SAT	98	197	SWIVEL	1	
REV	A	198	SWIVEL	1	
SAT	99	199	SWIVEL	1	
REV	A	200	SWIVEL	1	
SAT	100	201	SWIVEL	1	
REV	A	202	SWIVEL	1	
SAT	101	203	SWIVEL	1	
REV	A	204	SWIVEL	1	
SAT	102	205	SWIVEL	1	
REV	A	206	SWIVEL	1	
SAT	103	207	SWIVEL	1	
REV	A	208	SWIVEL	1	
SAT	104	209	SWIVEL	1	
REV	A	210	SWIVEL	1	
SAT	105	211	SWIVEL	1	
REV	A	212	SWIVEL	1	
SAT	106	213	SWIVEL	1	
REV	A	214	SWIVEL	1	
SAT	107	215	SWIVEL	1	
REV	A	216	SWIVEL	1	
SAT	108	217	SWIVEL	1	
REV	A	218	SWIVEL	1	
SAT	109	219	SWIVEL	1	
REV	A	220	SWIVEL	1	
SAT	110	221	SWIVEL	1	
REV	A	222	SWIVEL	1	
SAT	111	223	SWIVEL	1	
REV	A	224	SWIVEL	1	
SAT	112	225	SWIVEL	1	
REV	A	226	SWIVEL	1	
SAT	113	227	SWIVEL	1	
REV	A	228	SWIVEL	1	
SAT	114	229	SWIVEL	1	
REV	A	230	SWIVEL	1	
SAT	115	231	SWIVEL	1	
REV	A	232	SWIVEL	1	
SAT	116	233	SWIVEL	1	
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SAT	117	235	SWIVEL	1	
REV	A	236	SWIVEL	1	
SAT	118	237	SWIVEL	1	
REV	A	238	SWIVEL	1	
SAT	119	239	SWIVEL	1	
REV	A	240	SWIVEL	1	
SAT	120	241	SWIVEL	1	
REV	A	242	SWIVEL	1	
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SAT	122	245	SWIVEL	1	
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SAT	123	247	SWIVEL	1	
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SAT	124	249	SWIVEL	1	
REV	A	250	SWIVEL	1	
SAT	125	251	SWIVEL	1	
REV	A	252	SWIVEL	1	
SAT	126	253	SWIVEL	1	
REV	A	254	SWIVEL	1	
SAT	127	255	SWIVEL	1	
REV	A	256	SWIVEL	1	
SAT	128	257	SWIVEL	1	
REV	A	258	SWIVEL	1	
SAT	129	259	SWIVEL	1	
REV	A	260	SWIVEL	1	
SAT	130	261	SWIVEL	1	
REV	A	262	SWIVEL	1	
SAT	131	263	SWIVEL	1	
REV	A	264	SWIVEL	1	
SAT	132	265	SWIVEL	1	
REV	A	266	SWIVEL	1	
SAT	133	267	SWIVEL	1	
REV	A	268	SWIVEL	1	
SAT	134	269	SWIVEL	1	
REV	A	270	SWIVEL	1	
SAT	135	271	SWIVEL	1	
REV	A	272	SWIVEL	1	
SAT	136	273	SWIVEL	1	
REV	A	274	SWIVEL	1	
SAT	137	275	SWIVEL	1	
REV	A	276	SWIVEL	1	
SAT	138	277	SWIVEL	1	
REV	A	278	SWIVEL	1	
SAT	139	279	SWIVEL	1	
REV	A	280	SWIVEL	1	
SAT	140	281	SWIVEL	1	
REV	A	282	SWIVEL	1	
SAT	141	283	SWIVEL	1	
REV	A	284	SWIVEL	1	
SAT	142	285	SWIVEL	1	
REV	A	286	SWIVEL	1	
SAT	143	287	SWIVEL	1	

ITEM NOMENCLATURE	QTY.	CODE IDENT.	MANUFACTURER	PART OR DWG NO.	NAME	MATERIAL	MATERIAL SPEC	REQ'D CERTS	C P H C N D N	ALTERNATE SPEC FOR GOVT REFERENCE	WT LBS	REMARKS	ITEM NO.
													1
1. SIDE PLATE	1	E301289	WGC	STL	Q0-S-741 GL-A36-h,r.								
2. RING	1	0303913	WGC	STL	GL-A36-h,r.								
3. STOP BLOCK	1	C304623	WGC	YAR	SEE DWG.								
4. HEX HD CAPSCREW	15		COMML	S.STL	COMML								
5. LOCKWASHER	15		COMML	S.STL	COMML								
6. DOWEL PIN	12		COMML	S.STL	COMML								
7. DOWEL PIN	2		COMML	S.STL	COMML								
8. CAM RAMP	1	B304800	WGC	STL	Q0-S-741 GL-A36-h,r.								

SIZE      CODE IDENT. NO.      PL 0303916  
 UNIT -      B      16603      IN SLEEVES      2 C.

A

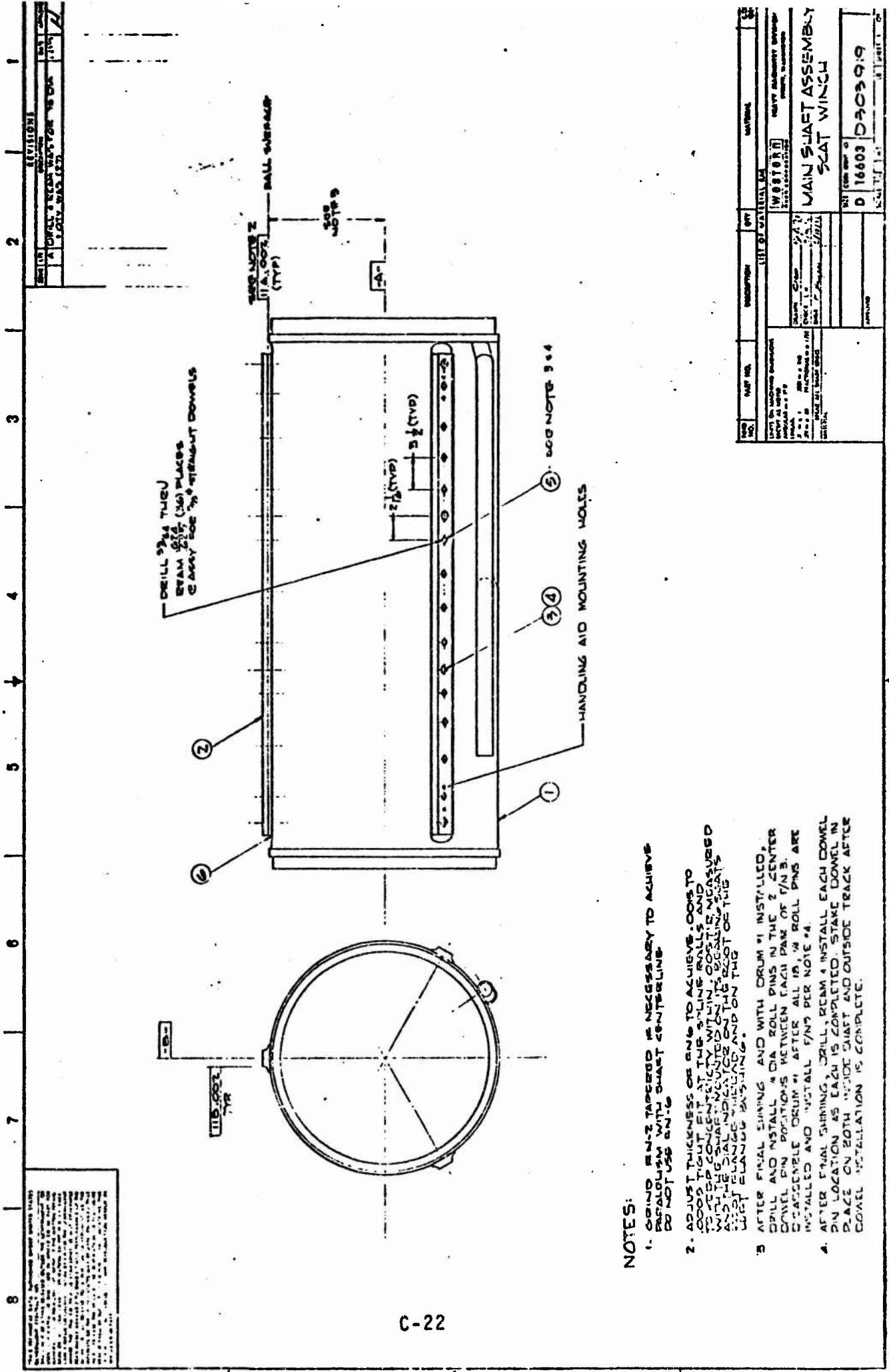


**CONTROL SHEET**

**NOTES:**

C-20

ITEM NO.	NOMENCLATURE	QTY.	CODE IDENT.	MANUFACTURER PART OR DNC NO.	NAME	MATERIAL	MATERIAL SPEC	RECD CERTS			ALTERNATE SPEC FOR GOVT REFERENCE	WT LBS	REMARKS
								C	P	N			
1	MAIN SHAFT	1	0303911	WGC	S. STL.	QD-S-741CL A36-HR TYPE 316 L							
2	INNER TRACK	3	C304608	WGC	S. STL.	QD-S-65-CL					1/2-20 NF X 1" LG		
3	SOCKET SCREW	12		COMML	S. STL.	COMML					1/2 MED		
4	WASHER, LK, SPR.	12		COMML	S. STL.	COMML							
5	STRAIGHT DOWEL	27		COMML	S. STL.	COMML					7/8 X 1-1/2 LG 300 SERIES		
6	LAMINATED SHIMS	2	B304584	WGC	S. STL.	COMML							



## CONTROL SHEET

NOTES

- Painting instructions are listed on B-3045.
  - Lubrication drawing is C-30475.

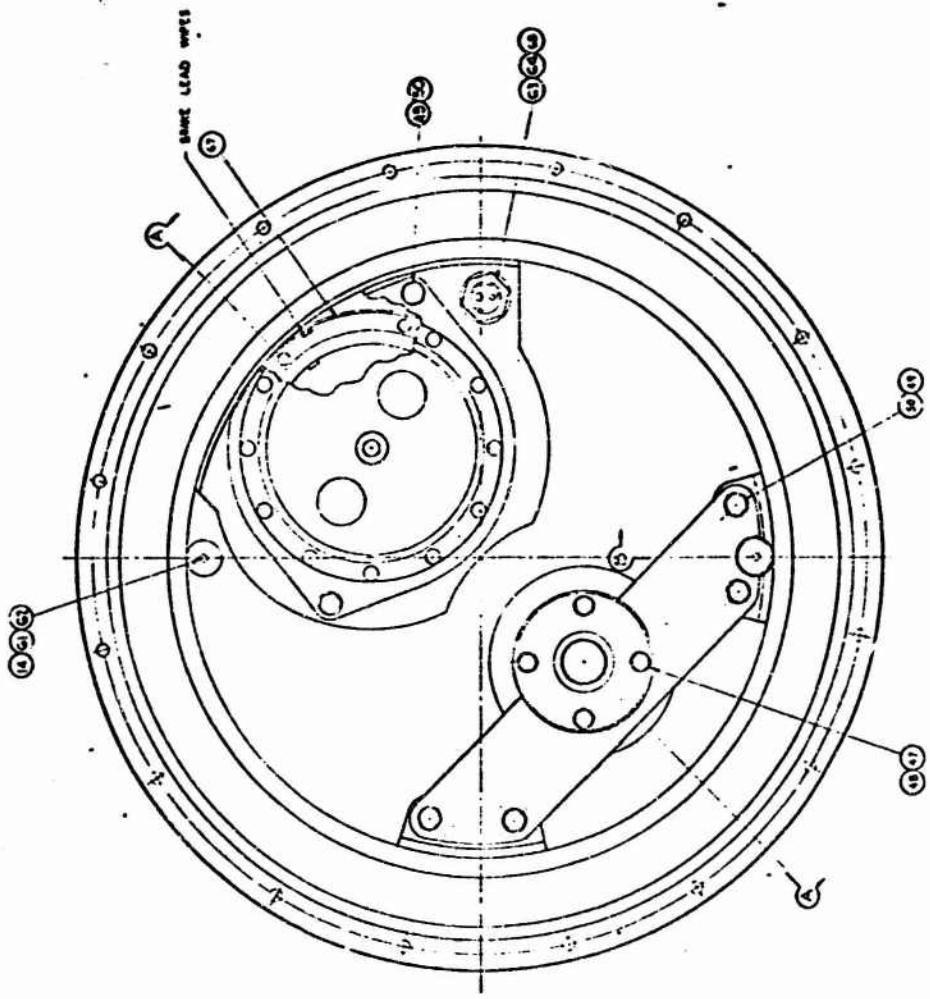
C-23

Line No.	MATERIAL	OTR.	CODE IDENT.	PART OR DRG NO.	MANUFACTURER	NAME	MATERIAL	MATERIAL SPEC	REMARKS				WT LBS	REFLINES	ALTERNATE SPEC FOR GORY	
									C	H	C	H	B	M		
1	PRIMARY PLANET GEAR	1	16603	D303925	WGC		STL	ASTM A 36								
2	L.S. PLANET GEAR	1	16603	D303926	WGC		STL	A361 A36								
3	PLANETARY RING GEAR	1	16603	D303927	WGC		X									HEAT TREAT 300-320 BHN
4	INNER SHAFT	1	16603	D303928	WGC		X									
5	PLANETARY PINION	1	16603	C304633	WGC		STL	AISI 4140								HEAT TREAT 350-370 BHN
6	LOW SPEED PLANET GEAR	3	16603	C304634	WGC		STL	AISI 4140								HEAT TREAT 320-340 BHN
7	SECONDARY PLANET PINION	1	16603	C304635	WGC		STL	AISI 4140								HEAT TREAT 350-370 BHN
8	DRIVE SHAFT GLAND	1	16603	C304636	WGC		X									
9	OUTER BEARING	1	16603	C304637	WGC		STL	ASTM A-36								
10	COMPENSATOR BASE	1	16603	C304638	WGC		STL	VARIOUS								
11	COMPENSATOR COVER	1	16603	C304639	WGC		STL	VARIOUS								
12	DRIVE SHAFT OUTER BEARING RETAINER	1	16603	B303913	WGC		STL	AISI 4140								HEAT TREAT 250-280 BHN
13	DRAIN & FILL PIPE	2	16603	B303915	WGC		STL	ASTM A36								1/2" BLK. SCHED. 80
14	COMPENSATOR SPRING	1	16603	B303916	WGC		S. STL									
15	COMPENSATOR PISTON	1	16603	B303917	WGC		STL	VARIOUS								
16	PISTON GUIDE	1	16603	B303918	WGC		S. STL	TYPE 304L								
17	COMPENSATOR DIAPHRAGM	1	16603	B303919	WGC		VAR									
18	SHARP BUSHING	3	16603	B303920	WGC		STL	AISI 4140								HEAT TREAT 250-280 BHN
19	PLANET SHAFT	3	16603	B303921	WGC		STL	AISI 4140								HEAT TREAT 250-280 BHN
20	THRUST WASHER	1	16603	B303922	WGC		BRZ	SAE 660								
21	THRUST BUSHING	1	16603	B303923	WGC		BRZ	SAE 660								
22	HIGH SPEED GEAR	1	16603	B303924	WGC		STL	AISI 4140								HEAT TREAT 300-320 BHN
23	SEAL RING	1	16603	B303925	WGC		S. STL	TYPE 304L								
24	PRIMARY PLANET GEAR	3	16603	B303926	WGC		SIL	AISI 4140								HEAT TREAT 320-340 BHN
25	HIGH SPEED PINION	1	16603	B303927	WGC		STL	AISI 4140								HEAT TREAT 350-370 BHN
26	THRUST WASHER	1	16603	A302013	WGC		BRZ	SAE 660								

No.	NOMENCLATURE	Qty.	CODE IDENT.	PART OR DNG. NO.	MANUFACTURER NAME	MATERIAL	MATERIAL SPEC	REQ'D CERTS				ALTERNATE SPEC FOR GOVT REFERENCE	WT LBS	REMARKS	CLASS
								C	P	H	C <sub>T</sub>	N	M		
17	COMPENSATOR ROD	1	16603	A302014	MGCC	S. STL.	TYPE 303						X		
22	BALL BEARING	6	52676	6212NR	SKF								X		
30	BALL BEARING	6	52676	6206NR	SKF								X		
31	BALL BEARING	5	52676	6209	SKF								X		
32	BALL BEARING	1	52676	1207	SKF								X		
33	OIL SEAL	1		7203ST-LPD	J. MANVILLE								X		
24	OIL SEAL	1		10404-LPD	J. MANVILLE								X		
35	OIL SEAL	1		10060-LPD	J. MANVILLE								X		
26	OIL SEAL	1		10855-LPD	J. MANVILLE								X		
37	"O" RING	1	92003	2-365	PARKER								X		
38	"O" RING	1	92003	2-388	PARKER								X		
39.	RETAINING RING	1		5100-250	TRUARC								X		
40	RETAINING RING	1		5100-137	TRUARC								X		
41	HEX HD PLUG	1	92003	EF20N	PARKER								X		
42	KEY	1	16603	AK-13F-1	MGCC	SIL	AISI 1018						X		
43	HEX HD BOLT	1			STL								X		
44	SO2 HD CAPSCREW	3			STL								X		
45	SO2 HD CAPSCREW	14			STL								X		
46	LOCK WASHER	3			STL								X		
47	HEX HD CAPSCREW	4			ST. STL								X		
48	LOCK WASHER	4			ST. STL								X		
49	HEX HD CAPSCREW	6			ST. STL								X		
50	LOCK WASHER	6			ST. STL								X		
51	DOWEEL PIN	3			ALLEN	STL							X		
52	DOWEEL PIN	4			ALLEN	STL							X		
53	HEX HD CAPSCREW	2			ST. STL								X		
54	KEY	1	16603	AK-11R-1		STL	AISI 1018						X		

SICKLE CO. ID. NO. **B | 16603 | PL 0303929**  
 SCALE **1/4"** INCHES 3 OF 4  
**1/2"** INCHES 3 OF 4

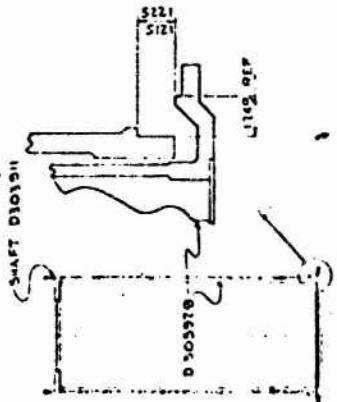
No.	INNENATURE	QTY.	CODE	IDENT.	MANUFACTURER	PART OR ORG NO.	NAME	MATERIAL	MATERIAL SPEC	REMARKS				WT LBS	REMARKS		
										C	P	H	C	N	D	M	
55	LOCKWASHERS	14						STL				X					
56	LOCKWASHERS	12						STL	STL			X					
57	SOC HC CAPSCREW	12						STL	STL			X					
58	LOCK NUT	1	13689	20FA616	FLEXLOC			STL	STL			X					
59	"O" RING	1	92003	2-268	PARKER							X					
60	"O" RING	1	92003	2-12	PARKER							X					
61	QUICK DISCONNECT	1	2	78357	S3VHCG6-6H		SNAP TITE		STL	STL		X					
62	DUST PLUG	2	78357	S6 SMPH-6			SNAP TITE		STL	STL		X					
63	ELECTRICAL CONNECTOR	1	06324	GL30G 2P BC	GLENAIR	VARIOUS						X					
64	"O" RING	1	92003	2-213	PARKER	BONA N						X					
65	Brake Pinion	1	1A203	C304709	WGC		STL										
66	SWCA DISCVENT NIPPLE	2	7B357	V-IN6-6M		SNAP TITE		STL									
67	SWCA DISCVENT NIPPLE	1	05805	C-671-1A	STEARNS		VAR.										
68	TELEGRAM COIN	1		C-3025F	GLENAIR		VAR.										
69	SWCA DISCVENT	1	C-6724	EL150-10	GLENAIR		VAR.										
70	SWCA PORT NOZZLET	1	0534	GL22-12	GLENAIR		VAR.										
71	SWCA NOZ	1	05805		STEARNS		VAR.										
72	SWCA NOZ	1			STEARNS		VAR.										
73	SWCA NOZ	1			STEARNS		VAR.										
74	SWCA NOZ	1			STEARNS		VAR.										
75	SWCA NOZ	1			STEARNS		VAR.										
76	KEY	1	14423	Ak-13E-1	W.G.		STL	AISI 1045									



**NOTE 1: ASSEMBLY AND DISASSEMBLY PRECAUTIONS:**  
Until the initial Smart Assembly D303920 has been installed we  
strongly recommend that -  
1. - all SWP and primary planet cases are not re-  
assembled until the main Smart cannot be safely or successfully  
disassembled.  
2. - the main Smart can only be safely reassembled after it has been  
removed from the planet case.  
3. - the main Smart must be held firmly by the planet  
case handle when being handled.  
4. - the main Smart must be held firmly by the planet  
case handle when being handled.

PINS - THE SUGAR ARE TO BE STAPLED IN PLACE AT

תְּנַשֵּׁא בְּנֵי כָּל־הָרָקֶב

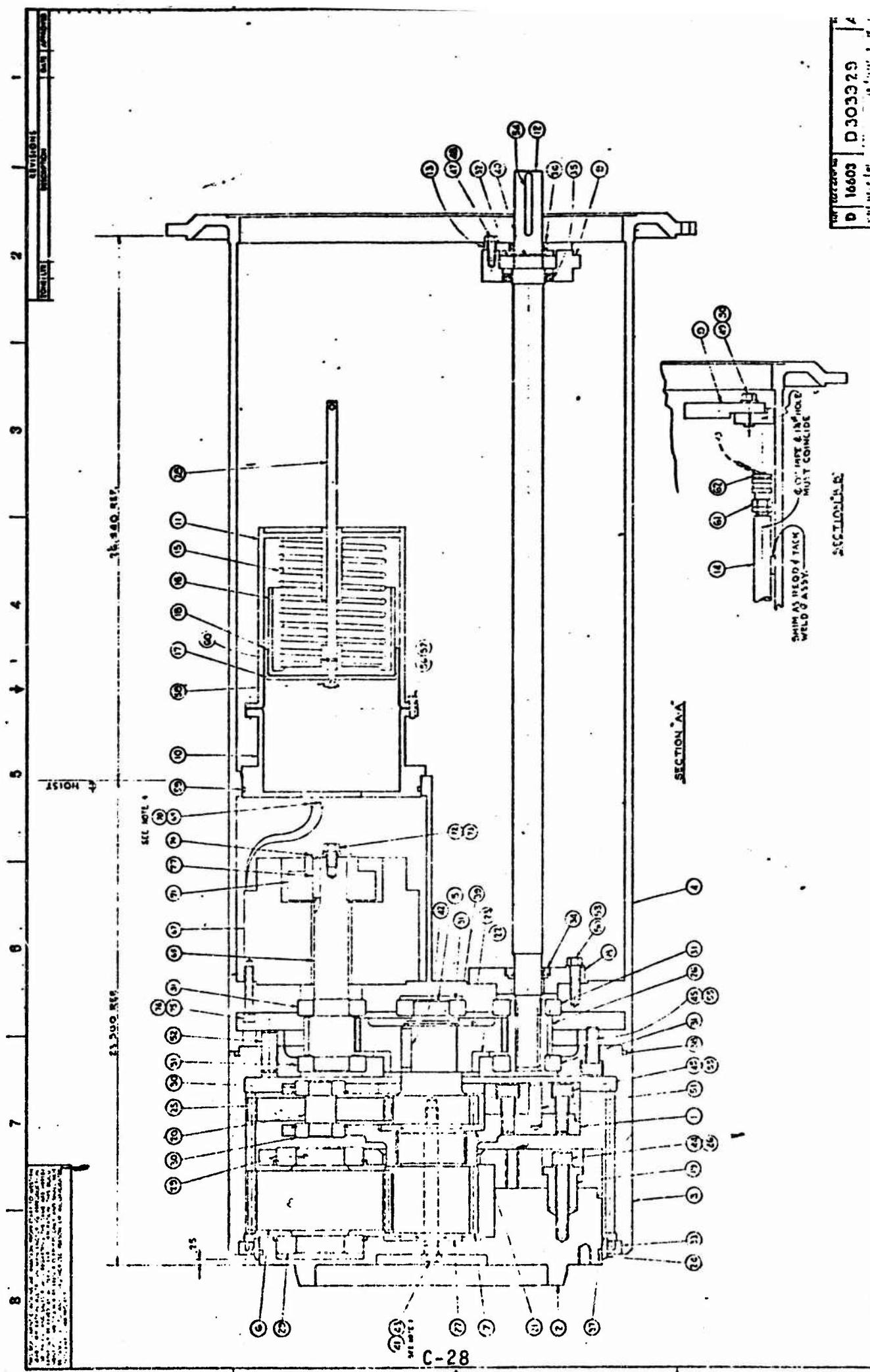


C-27

A. SPRUE, SPRUE ASSEMBLY D 20592 IS PLACED AS SHOWN,  
SCEW P/N 35 SHOULD NOT BE INSTALLED AND DRIVE SHAWT P/N 12  
IS NOT REQUIRED. BOLT P/N 45 IS TIGHTENED TO 30 LB-FT. TORQUE.

C. THE CORRECT MEASUREMENT AT THE BEARING SEAT IS 1 1/16 IN. AND THE THICKNESS OF THE GUESS WASHER #127 IS ADJUSTED TO GIVE THE PROPER BEARING SEAT MEASUREMENT.

NOTE & USE THE BRIGHT LEAD & RED 12 HOURS LONG AND SOLID FOR 5 TO 10 DAY TERM.  
IF THE STATE IS NOT TALLED, PLUG THE SETS IN TO THE BRIGHT CIRCUIT FOR 5 TO 10.



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ΕΓΓΟΝΑΙΑ

C-28

APPENDIX D  
SCAT WINCH TEST PROCEDURE

D-1

## REVISIONS

ZONE	LTR	DESCRIPTION	DATE	APPROVED
	A	TEST COMPLETELY REWRITTEN IN GREATER DETAIL AND PER CUSTOMER'S REVIEW.	12/14/72	JK
	B	ADDED TEST RESULTS	3/2/73	JK

## TEST PROCEDURE

SCAT RM WINCH

JOB 32158

LIMITS ON  
MACHINED DIMENSIONS  
EXCEPT AS NOTED  
ANGULAR  $\pm 10^\circ$   
LINEAR  
 $X = \pm .1$   
 $.0X = \pm .03$   
 $.00X = \pm .010$   
FRACTIONAL  $\pm 1/32$

BREAK ALL  
THROUGH FINESESHeavy Machinery  
Division

DRAWN	12/15/72			
CHECK				
ENGR	1/15/73			
APPROVED		SIZE	CODE IDENT NO.	REV
		A	16603	A
		SCALE	WT.	1 OF 9

**1.0 SCOPE:**

THIS TEST IS TO CONFIRM THE MECHANICAL DESIGN OF THE FLEETING DRUM CONFIGURATION OF THE SCAT WINCH

**2.0 IDENTIFICATION OF ITEM:**

ASSEMBLY DRAWING E301207

**3.0 DESCRIPTION OF TEST:**

THE SCAT WINCH WILL BE INCLINE MOUNTED AS SHOWN IN FIGURE 1. ROTATIVE POWER TO BE SUPPLIED BY A HYDRAULIC MOTOR AND WGC VARIABLE DELIVERY POWER UNIT.

THE HYDRAULIC MOTOR PRESSURES AND SHAFT RPM AS WELL AS FUNCTIONAL OPERATION TO BE RECORDED AS DATA.

TEST SEQUENCE TO BE AS FOLLOWS:

- 3.1 LATCH OPERATION VERIFICATION.
- 3.2 NO LOAD TEST AT VARIOUS SPEEDS.
- 3.3 LOAD TESTS AT VARIOUS LINE TENSIONS.
- 3.4 FULL LOAD TEST.
- 3.5 BRAKE TEST.

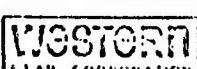
**4.0 TEST PREREQUISITES:**

- 4.1 LUBRICATE WINCH BY FILLING UNIT WITH MIL-L-2105 GRADE 90 OIL THRU PT 61. (REF. D303929 SHT 2, SEC. B-B). FOLLOW PURGE INSTRUCTIONS ON C304725, CONTINUING UNTIL AIR FREE OIL IS OBSERVED.

AFTER COMPLETION OF PURGE, CHECK AND IF NECESSARY FILL WITH OIL UNTIL PRESSURE COMPENSATOR (PT. 29, ZN-C4 D303929) IS EXTENDED APPROXIMATELY 3 INCHES FROM FREE POSITION.

GREASE PT. 32 ZN-B2, SHT. 2, ON D303929. NO OTHER PETROLEUM LUBRICATION IS REQUIRED.

FRESH WATER LUBRICATION MAY BE SUPPLIED TO THE DRUM BEARINGS DURING THE LOAD TESTS. NO LUBRICATION OTHER THAN INCIDENTAL WATER WILL BE SUPPLIED TO THE RECIRCULATING BALL SLIDE BEARINGS AT ANYTIME. WATER LUBRICATION WILL NOT BE INCORPORATED UNLESS DRUM BEARING TEMPERATURES EXCEED 40° F. ABOVE AMBIENT. (BALL SLIDE BEARINGS ARE MOYL-LUBED DURING ASSEMBLY.)

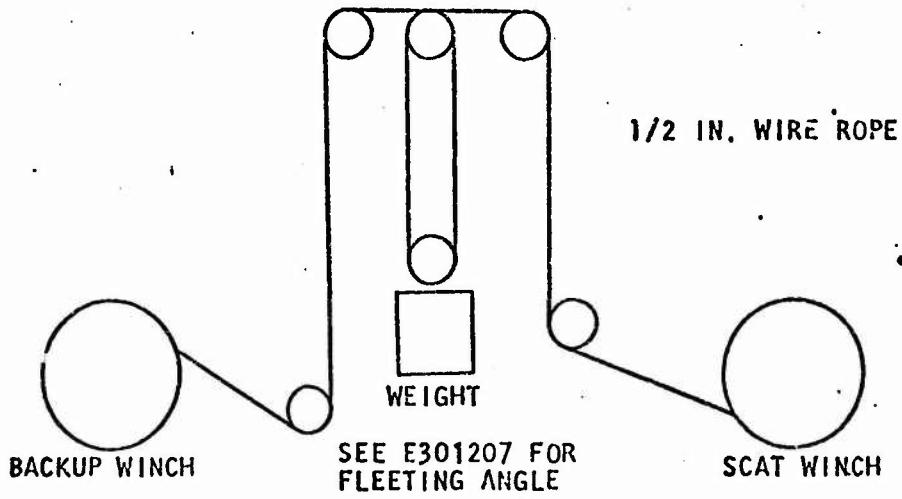


Heavy Machinery  
Division

EVERETT, WASHINGTON 98201

SIZE	CODE IDENT NO.	
A	16603	A 302795
SCALE		SHEET 2 OF 9

- 4.2 CHECK THAT DRUM THREAD AREAS ARE CLEAN.
- 4.3 MOUNT WINCH AS SHOWN IN FIGURE 1 AND CONNECT HYDRAULIC MOTOR TO INPUT SHAFT. DO NOT RIG AS YET.



NOTE: MOUNT SCAT WINCH WITH DRUM AXIS INCLINED 10°. RAISED END OF WINCH TO BE OPPOSITE MOTOR INPUT SHAFT.

FIGURE 1

5.0 DETAILED TEST DESCRIPTION.

5.1 LATCH OPERATION TEST.

CAUTION: THRU-OUT THE LATCHI OPERATIONAL TEST, SET AND READJUST THE HYDRAULIC POWER UNIT'S RELIEF VALVE NO MORE THAN 150 PSI ABOVE THAT REQUIRED BY THE MOTOR.

5.1.1 OPERATE THE WINCH VERY SLOWLY IN PAY-OUT (APPROXIMATELY 50 MTR RPM) AND OBSERVE IF ANY ROUGHNESS IN OPERATION OCCURS. RECORD MOTOR DATA. CONTINUE UNTIL A DRUM ON THE WINCH APPROACHES A LATCH POINT. ROTATE THE DRUM INTO THE LATCH POINT AS SLOW AS POSSIBLE, OR BY JOGGING,

WESTCRN GEAR CORPORATION	Heavy Machinery Division	SIZE A	CODE IDENT NO. 16603	A 302795
EVERETT, WASHINGTON 98201		SCALE		SHEET 3 of 9

SUCH THAT ANY INCIDENCE OF BINDING AND/OR LOCKUP,  
SHOULD IT OCCUR, CAN BE OBSERVED AND OPERATION STOPPED.

AFTER PASSING THROUGH LATCH POINT, REPEAT, OPERATING  
WINCH IN THE OPPOSITE DIRECTION.

- 5.1.2 SLOWLY INCREASE THE WINCH SPEED IN THE STEPS NOTED AND  
OPERATE THE LATCH IN BOTH DIRECTIONS. RECORD MOTOR  
DATA.
- 5.1.3 CONTINUE OPERATING THE WINCH IN PAY-OUT DIRECTION RE-  
PEATING STEPS 5.1 AND 5.2 FOR DRUM #2.
- 5.1.4 REPEAT STEP 5.3 FOR THE REMAINING DRUM.

CAUTION: DO NOT OPERATE IN PAYOUT DIRECTION ANY  
FASTER THAN 50 MOTOR RPM AS THIS IS THE  
END-OF-TRAVEL HARD STOP.

#### 5.2 NO LOAD TESTS.

SET HYDRAULIC POWER UNIT RELIEF VALVE TO 300 PSI ABOVE THAT  
REQUIRED IN 5.1.4.

CAUTION: DO NOT OPERATE WINCH INTO END-OF-TRAVEL HARD  
STOP LIMITS, ESPECIALLY AT HIGHER SPEEDS, AS  
POSSIBLE GEAR TRAIN DAMAGE MAY RESULT.

- 5.2.1 OPERATE WINCH FROM FULL PAY-OUT TO FULL HAUL-IN WITHOUT  
CABLE FOR 15 MINUTES IN EACH DIRECTION, AT HALF SPEED  
(900 MOTOR RPM). RECORD MOTOR DATA, GEAR CASE, AND  
DRUM BEARING TEMPERATURES.
- 5.2.2 REPEAT STEP 5.2.1 EXCEPT OPERATE AT FULL SPEED (1800  
MOTOR RPM.).

#### 5.3 LOAD TESTS.

SET HYDRAULIC POWER UNIT RELIEF VALVE TO 200 PSI ABOVE THAT  
PRESSURE REQUIRED BY THE HYDRAULIC MOTOR TO DEVELOP 40 HP  
@ 1800 RPM. (SET AT 1770 PSI)

- 5.3.1 RIG WINCH PER FIGURE 1. SET UP FRESH WATER SOURCE FOR  
A FLOW OF 1 - 2 GPM. DIRECT WATER FLOW AGAINST GEAR  
CASE END THROUGH THE RIGHT SIDE PLATE OF WINCH. (PN  
#1, REF E301207)

NOTE: IF REQUIRED DUE TO BEARING TEMPERATURE RISE OF  
400 F. ABOVE AMBIENT DURING THE FOLLOWING TESTING,  
SET UP WATER SOURCE FOR A FLOW OF 1-2 GPM. DIRECT  
WATER FLOW AGAINST GEAR CASE END THROUGH THE RIGHT  
SIDE PLATE OF WINCH. (PN #1, REF DWG E301207)

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- 5.3.2 APPLY LIGHT LINE LOAD (100-500#) AND OPERATE WINCH AT SLOW SPEED ( $\approx$  500 MOTOR RPM) AND OBSERVE CABLE SPOOLING. MONITOR AND RECORD MOTOR DATA, ESPECIALLY NOTING ANY INDICATION OF ROUGHNESS. OPERATE ENTIRELY ON #1 DRUM, DO NOT OPERATE THROUGH THE LATCHES.
- 5.3.3 OPERATE WINCH WITH LIGHT LINE VERY SLOWLY THROUGH LATCHES AND OBSERVE CABLE SPOOLING ON REMAINING DRUMS. MONITOR AND RECORD MOTOR DATA, ESPECIALLY NOTING ANY INDICATION OF ROUGHNESS WITH LINE SHIFTING FROM ONE DRUM TO ANOTHER.
- 5.3.4 OPERATE WINCH FROM FULL HAUL-IN TO FULL PAY-OUT UNDER LIGHT LINE LOAD. OPERATE WINCH AT VARIOUS CONSTANT SPEEDS THROUGH LATCH POINTS TO DETERMINE WHETHER WINCH MOTOR SLOW DOWN'S FOR LATCH OPERATION ARE OR ARE NOT REQUIRED. RECORD LATCH/WINCH OPERATION AND SPEED REQUIRED FOR SMOOTH LATCH OPERATION.
- 5.3.5 OPERATE WINCH FROM FULL HAUL-IN TO FULL PAY-OUT UNDER 2800# LINE LOAD. OPERATE WINCH FOR 15 MINUTES IN EACH DIRECTION AT HALF SPEED (900 MOTOR RPM.). RECORD MOTOR DATA, GEAR CASE AND BEARING TEMP.
- NOTE: SLOW DOWN TO SPEED DETERMINED IN 5.3.4 FOR ALL LATCHING POINTS. IF NO SLOW DOWN IS REQUIRED, STRIVE FOR CONSTANT SPEED OPERATION. THIS REQUIREMENT IS APPLICABLE DURING ALL FURTHER TESTING OPERATIONS.
- 5.3.6 REPEAT STEP 5.3.5 EXCEPT OPERATE AT FULL SPEED (1800 MOTOR RPM).
- 5.3.7 OPERATE WINCH FROM FULL HAUL-IN TO FULL PAY-OUT UNDER 5600# LINE LOAD. OPERATE WINCH FOR 15 MINUTES AT HALF SPEED AND 45 MINUTES AT FULL SPEED. RECORD MOTOR DATA LUB., WATER, GEAR CASE AND BEARING TEMPERATURES. ALSO NOTE CONDITION AND OPERATION THREADS AND LATCH OPERATION.

#### 5.4 BRAKE TEST

- 5.4.1 SET WINCH LEVEL. DISCONTINUE WATER LUB. FLOW.
- 5.4.2 WITH WIRE ROPE FULLY LOADED ON DRUMS, APPLY A 14,000# LINE LOAD WITH BRAKE SET AND HOLD FOR 10 MINUTES. CREEPAGE OF BRAKE IN EXCESS OF ONE FOOT LINE PAY-OUT IS UNACCEPTABLE. CREEP MEASUREMENT ZERO TO BE TAKEN AFTER FULL LINE TENSION IS REACHED.

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5.4.3 REPEAT STEP 5.3.7 EXCEPT FOR LENGTH OF RUN TO ASSURE PROPER WINCH OPERATION. LENGTH OF RUN TO BE ONLY AS LONG AS REQUIRED TO ASSURE PROPER OPERATION.



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## DATE SHEET

DATE NO LOAD 1/31 & 2/1/73  
LOAD 2/23 & 2/25/73

ITEMINITIAL

- 4.1 WINCH LUBRICATED AND AIR FREE.  
 4.2 DRUM THREADS CLEAN  
 4.3 WINCH MOUNTED  
 5.1.1 COMMENTS, LATCH OPERATION

LATCH WOULD FAIL TO OPERATE PROPERLY IN PAYOUT DIRECTION AT MOTOR INPUT SPEEDS BELOW 500 RPM FOR DRUMS # 2 & 3, AND 350 RPM FOR DRUMS # 2/1. INHAUL LATCH FAILURES OCCURRED BELOW 150 RPM. LATCH IMPACT NOISE BECAME EXCESSIVE (NO LOAD) ABOVE 1000 RPM

- 5.1.2 NO LOAD, DRUM #1  
 COMMENTS:

DATA FOR ROTATION DOWN 10° INCLINE. NOMINAL 20 PSI INCREASE FOR ROTATION UP INCLINE.

MOTOR @ <u>150</u> PSI	&	<u>50</u> RPM.
MOTOR @ <u>180</u> PSI	&	<u>110</u> RPM. 210
MOTOR @ <u>205</u> PSI	&	<u>170</u> RPM. 560
MOTOR @ <u>275</u> PSI	&	<u>450</u> RPM. 930

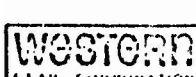
HYDRAULIC MOTOR DATA: MAKE VICKERS EFF. 95.1% @ 900 RPM  
93.9% @ 1800 RPM

MODEL ME-2020-30-95-21 TYPE PISTON - FIXED VOLUME DISPLACEMENT 5.98 in³ REV.

- 5.1.3 NO LOAD, DRUM #2  
 COMMENTS:

NOMINAL 25 PSI INCREASE FOR DRUM ROTATION UP INCLINE.

MOTOR @ <u>110</u> PSI	&	<u>100</u> RPM. 85
MOTOR @ <u>140</u> PSI	&	<u>170</u> RPM. 215
MOTOR @ <u>200</u> PSI	&	<u>220</u> RPM. 470
MOTOR @ <u>280</u> PSI	&	<u>450</u> RPM. 870



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5.1.4 NO LOAD, DRUM #3  
COMMENTS:

UNABLE TO READ PRESSURE  
DIFFERENCE FOR ROTATION UP INCLINE  
DUE TO PRESSURE GAUGE BOUNCE

MOTOR @ 150 PSI & 50 RPM.  
MOTOR @ 190 PSI & 100 RPM. 180  
MOTOR @ 225 PSI & 280 RPM. 400  
MOTOR @ 275 PSI & 450 RPM. 900

5.2.1 NO LOAD, HALF SPEED  
TEMP. AMBIENT = 71° F

MOTOR SPEED	<u>950</u> MIN. <u>960</u> MAX. RPM.
MOTOR PRESSURE	<u>225</u> MIN. <u>280</u> MAX. PSI.
GEAR CASE TEMP.	<u>105</u> TO <u>114</u> °F.
LH BEARING	<u>80</u> TO <u>84</u> °F.
RH BEARING	<u>71</u> TO <u>74</u> °F.

5.2.2 NO LOAD, FULL SPEED  
TEMP. AMBIENT = 71° F

MOTOR SPEED	<u>1800</u> MIN. <u>1850</u> MAX. RPM.
MOTOR PRESSURE	<u>410</u> MIN. <u>450</u> MAX. PSI.
GEAR CASE TEMP.	<u>114</u> TO <u>142</u> °F.
LH BEARING	<u>84</u> TO <u>89</u> °F.
RH BEARING	<u>74</u> TO <u>81</u> °F.

5.3.2 LIGHT LINE, SLOW SPEED  
COMMENTS:

LINE TENSION	<u>470</u> LBS.
MOTOR SPEED	<u>920</u> RPM.
MOTOR PRESSURE	<u>425</u> PSI.

LINE SPOOLED ON WINCH DRUMS AND THROUGH  
DRUM TRANSITION AREAS WITH ABSOLUTELY NO PROBLEMS,  
NOISE, OR JUMPING WHAT SO EVER.

5.3.3 LIGHT LINE, LATCH OPERATION,

NO NOTICABLE FLUCTUATION - MOTOR PRESS — TG — PSI.  
PRESSURE SPIKES DURING FLUCTUATION - MOTOR SPEED — TO — PSI.

LATCH OPERATION. FOR NOMINAL PRESSURE INCREASE FROM DRUM #1  
TO DRUM #3, SEE LOAD DATA PRESS. MIN-MAX.

5.3.4 LIGHT LINE, LATCH SPEED

50 RPM, LATCH/WINCH OPERATION

(SMOOTH/ROUGH & ETC.)

100 RPM, LATCH/WINCH OPERATION

SEE DATA SECTION 5.1.1

RPM, LATCH/WINCH OPERATION

RPM, LATCH/WINCH OPERATION

HIGHEST SPEED STILL AFFORDING ACCEPTABLE WINCH  
OPERATION, NOISE/VIBRATIONS @ MOTOR 900 RPM.

COMMENTS: LATCH NOISE WAS SOMEWHAT QUIETER WITH  
LINE TENSION AS COMPARED TO NO LOAD/NO LINE.  
LATCH IMPACT NOISES BECAME EXCESSIVE ABOVE 1500  
RPM PAYOUT AND 1300 RPM INHAUL (WITH LINE TENSION)  
INCREASE IN TENSION DID NOT DECREASE LATCH NOISE TO  
ANY APPRECIABLE DEGREE.



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**5.3.5 HALF LOAD, HALF SPEED**  
**COMMENTS:**

PRESSURE VARIES APPROX.  
 100 PSI DURING EACH DRUM  
 REVOLUTION, MOST NOTICABLE ON  
 DRUM #3 OPERATION.

2/25/73 AMBIENT = 46°F

RUN MADE WITHOUT HYDRAULIC SYSTEM OIL FULLY  
 WARMED UP.

LINE TENSION	2800	LBS.
MOTOR SPEED	920 MIN. 950 MAX.	RPM.
MOTOR PRESSURE	800 MIN. 1025 MAX.	PSI
GEAR CASE TEMP.	50 TO 60 °F.	
LH BEARING	48 TO 48 °F.	
RH BEARING	48 TO 50 °F.	

**5.3.6 HALF LOAD, FULL SPEED**  
**COMMENTS:**

100 PSI SWING PER  
 DRUM REV.

AMBIENT = 46°F

LINE TENSION	2800	LBS.
MOTOR SPEED	1800 MIN. 1820 MAX.	RPM.
MOTOR PRESSURE	750 MIN. 1025 MAX.	PSI
GEAR CASE TEMP.	60 TO 94 °F.	
LH BEARING	48 TO 52 °F.	
RH BEARING	50 TO 53 °F.	

**5.3.7 FULL LOAD, HALF SPEED**

150 PSI SWING PER  
 DRUM REV.

AMB. = 46°F

IF USED, WATER FLOW RATE

LINE TENSION	5600	LBS.
MOTOR SPEED	900 MIN. 920 MAX.	RPM.
MOTOR PRESSURE	800 MIN. 1325 MAX.	PSI
GEAR CASE TEMP.	92 TO 103 °F.	
LH BEARING	54 TO 60 °F.	
RH BEARING	53 TO 56 °F.	
NOT USED		GPM.

**FULL LOAD, FULL SPEED**

150 - 200 PSI SWING  
 PER DRUM REV.

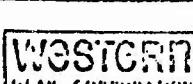
LINE TENSION	5600	LBS.
MOTOR SPEED	1810 MIN. 1800 MAX.	RPM.
MOTOR PRESSURE	1000 MIN. 1550 MAX.	PSI
GEAR CASE TEMP.	103 TO 120 °F.	
LH BEARING	60 TO 60 °F.	
RH BEARING	56 TO 56 °F.	

**5.4.2 BRAKE TEST**  
**COMMENTS:**

LINE TENSION 14,500 LBS.  
 LINE CREEP 0 IN.

NO DRUM OR INPUT SHAFT ROTATION NOTICED

ALL POST BRAKE TEST PRESSURES AND FULL  
 LOAD OPERATION WERE NORMAL.



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